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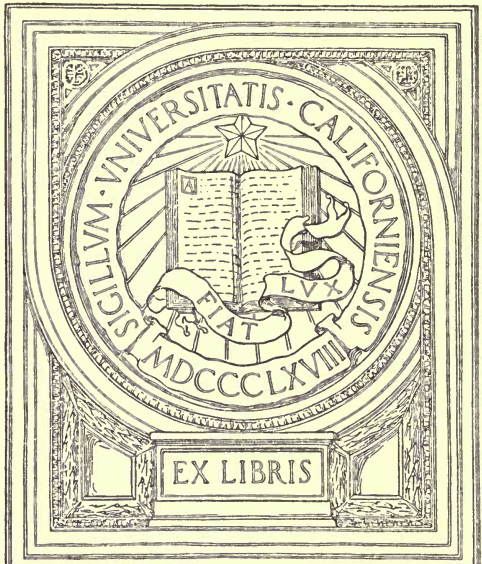

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A TREATISE ON MALACOLOGY;

OR THE NATURAL CLASSIFICATION OF SHELLS AND SHELL-FISH.

By William Swainson F.R.S. & F.L.S. &c.&c.

W. Swainson del. F. Finden sc.

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A TREATISE

ON

MALACOLOGY;

OR

SHELLS AND SHELL-FISH.

PART I.

A GENERAL SURVEY OF THE TESTACEOUS MOLLUSCA.

CHAPTER I.

INTRODUCTORY OBSERVATIONS. — THE MOLLUSCA IN GENERAL. — THE CHARACTERS AND ANALOGIES OF THE THREE PRIMARY DIVISIONS OR CLASSES; NAMELY, THE ACRITA, THE RADIATA, AND THE TESTACEA. — NOTES ON THE BIBLIOGRAPHY AND THE EXISTING CLASSIFICATIONS OF THE LATTER.

(1.) In our last volume, we completed the survey of those great divisions of animals which, from possessing a bony skeleton, are called the Vertebrata. Our present treatise will be devoted to a far more numerous, but less interesting, assemblage, — namely, the Mollusca, or soft animals. These, with few exceptions, are either inhabitants of the ocean or of fresh waters. The majority are little known even to naturalists; and

hundreds of our readers may pass their lives without seeing one, save the slugs in their gardens, or the empty shells they once inhabited. Their aspect to the ordinary observer is strange and unprepossessing, without either the gracefulness of form, the activity of motion, or the richness of colouring which ornaments insects and vertebrated animals. Their manners and economy scarcely come within our cognisance, for their actions are carried on in an element we do not inhabit; hence they are rarely witnessed, and a few partial details is all that has yet been gathered to elucidate their history. Their soft and slimy bodies cannot be preserved so as to interest us even by their appearance, or to become objects of beauty or of popular interest; they are, in short, almost passed, "unheeded and unknown," except by the eye of Science.

(2.) The object of the series of volumes we are now producing, is, to give to the world what has never yet been attempted, —a philosophic survey of the works of nature, based upon the harmonious relations which every part bears to the whole. Partial systems, applicable to one branch only, and a crowd of anatomical facts, have been either omitted, or but slightly touched upon, as mere accessory helps to the paramount object of our labours. We have, indeed, got through the almost herculean task of arranging the whole of the *Vertebrata* according to their natural affinities and relations, even down to the sub-genera; but to follow up this plan with the annulose and the molluscous animals, would not only swell the Cabinet of Natural History to three times it prescribed limits, but would demand a knowledge which, individually, would be superhuman. The great truths, or, rather, the leading one, which the enlightened reader should have constantly brought before him is, the UNITY OF PLAN in the creation: this might be lost sight of, if the attention was long withdrawn from such enlarged conceptions, and occupied by a multiplicity of small details, fit only for the technical describer and the anatomical demonstrator.

(3.) Under all these circumstances, we must therefore treat the molluscous groups with great brevity: the leading divisions, indeed, of the whole will be briefly stated, sufficient to guide the researches of those who may be disposed to adopt our views of natural arrangement, and to analyse their contents; but this will be entirely subordinate to the primary intention of this volume, which, it will be seen, is almost exclusively confined to the TESTACEA. Limited as is our space, we shall endeavour to fill it in that way which promises to be of the greatest permanent, as well as practical, advantage to science. The arrangement of one class of the *Mollusca*, founded upon analysis, is obviously more valuable than a theoretical digest of the whole. We are seeking to place zoology upon a new basis. To discover and develope, as far as in us lies, the fundamental principles of the natural system; and to exhibit its component parts — not as detached portions, as if each had its own set of laws and its own little system of arrangement, but — as a vast and connected whole, throughout which the utmost harmony and the most perfect *unity of plan* pervades. To do this, however, with any degree of success, requires a fulness of detail, inseparably connected with the comprehensiveness of the subject, and the novelty of the design. It is due, not only to the scientific public, but to the labours of those great men whose opinions now reign paramount, that the systems now in use should not be lightly set aside. Hence a variety of details, unnecessary under other circumstances, becomes absolutely essential in these. Now, of the three classes of molluscous animals, the TESTACEA, or shell-fish, is that which possesses the greatest degree of popular, and even of scientific, interest. Their beautiful shelly habitations form some of the most interesting objects in our public museums and private collections. And although we should not consider ourselves bound to make *this* the only reason for a neglect of the other classes of the *Mollusca*, yet, under existing circumstances, we shall so far concede to

popular taste, as to devote our present volume almost entirely to so favourite a branch. This plan will enable us to submit nearly the whole of our investigations to the public; while we trust to do the same hereafter in regard to the remaining classes in a separate publication.

(4.) The innumerable groups of beings which we comprehend under the general name of *Mollusca*, are at once distinguishable from all other animals, by having no internal bones, like the *Vertebrata*; or no joints to their body and limbs, like the *Annulosa*, or insect tribes. In the first, the skeleton is internal; in the latter, it is external; but, in the *Mollusca*, it is entirely wanting. We might fill several pages on these anatomical distinctions; but simplicity is the soul of instruction; and we feel assured, that in following this rule, in the present instance, we are saving the unscientific reader a world of perplexing circumlocution.

(5.) We shall first glance at those characters drawn from the nervous system, which, it is thought, separate the *Mollusca* from the *Vertebrata* and the *Annulosa*. On a former occasion*, we have stated that their nervous system is variable; and that this variation pointed out the secondary divisions or classes, under which the leading zoologists of the age have, almost unanimously, arranged them. Thus, in the ACRITA, or polypes, the nervous system has been called granular; these granules, innumerable and minute, being generally dispersed over the bodies of these animals, which resemble "masses of transparent, homogeneous, mobile, and sensible pulp, and thus impregnating the whole with sensibility."† In

* Classification of Quadrupeds, p. 37.

† Such, at least, is the definition of the ACRITA of MacLeay; but our recent researches among the *Mollusca* induce us strongly to doubt the propriety of placing therein the greater part of those minute animals which that celebrated naturalist has arranged with the corals. Our present impression is, that the whole, or nearly so, of the true ACRITA, are compound zoophytes, or, in other words, plant-like animals; that the *Rotifera* and *Infusoria* are only prototypes of the *Acrita* in the circle of the *Radiata*; and that the annulose intestinal worms are the same among the *Annulosa*. As for the *Parenchymata*, it will be seen we have had no hesitation in placing them as the representatives of this class in the most aberrant order of the testaceous *Mollusca*. We feel, in short, more and more persuaded that the real contents of the order *Cyclobranchia* cannot be determined until the entire class of ACRITA has been sufficiently ana-

the second class, or the RADIATA, the nerves are arranged in a radiated or star-like manner; while in the testaceous *Mollusca*, or TESTACEA, the nervous system resides in four ganglions, either united in pairs, or altogether, which are embraced by a medullary collar.

(6.) It would thus appear that the three great divisions of MOLLUSCA are as much distinguished by their anatomical peculiarities, drawn from their nervous system, as they are by their external and more obvious characters. It is by these latter, however, that they are made intelligible to the generality of readers. Every one, therefore, will be at no loss to understand the external distinctions of these primary divisions: 1. The TESTACEA, or shell mollusks; 2. The RADIATA, or radiated mollusks; and, 3. The ACRITA, or polypes. The first being represented by shell-fish; the second, by starfish, sea eggs, and medusas; and the third, by corals, polypes, and other plant-like animals. We shall now, in the first place, point out the manner of their connection to the higher classes of animals, with the object of showing that they form an integral part of that vast circle which comprehends the whole of the animal world.

(7.) The primary distinction of vertebrated animals is, their being possessed both of an internal column, or back-bone, and of legs or other members which give them the power of locomotion: it follows, therefore, that if we found among the soft *Mollusca* any animals which really possessed these characters, however slightly developed, we should consider them as forming the passage from one class to the other; that is, from the *Vertebrata* to the *Mollusca*. Now, there is a whole tribe of animals which really present us with such a structure, and yet, in all other respects, they are so unlike the *Vertebrata*, that every writer places them with the

lysed. Between the *Doridæ* and the *Branchiopoda*, there must be, or have been, very many intervening forms: and we begin to think that Cuvier may not be very wrong in placing many, if not all, of his naked *Acephala* close to the *Branchiopoda*. But the analysis of the ACRITA can alone determine this question.

Testacea. This tribe is the *Cephalopoda,* or cuttlefish. It is among these only, out of the whole class of *Mollusca,* that we find a distinct, and often rigid, back-bone, —not, indeed, jointed or articulated, but performing the same office as the vertebrated column of a quadruped or a bird: others of its class have no limbs whatever; but the cuttlefish have immense arms, which are also used as legs; by these they crawl with the greatest facility on the bottom of the sea, swim quickly in the water, and retain the most forcible hold of such animals as they prey upon. The eyes of nearly all *Mollusca* are either small and indistinct, or are entirely wanting; in these, however, the eye is large, and as fully developed as in any vertebrated animal. There cannot, therefore, be the least doubt of the close approximation of the *Cephalopoda* to the *Vertebrata;* and as a large proportion of the fossil species were furnished with spiral shells, it follows that the testaceous class comes immediately after the *Vertebrata.* This affinity being established, we are at no loss to discover the point of junction between this and the next class, or the *Acrita.* The singular naked animals forming the *Nudibranchia* of Cuvier, have been very properly placed by many authors close to the tunicated polypes (*Tunicata*). Again, on the other side of the circle of *Acrita,* we have the genus *Zoanthus* and the *Polypes charnues* of the French writers, closely connected to the Radiata by *Priapulis* and other kindred forms; while the last vestige of the radiated structure is seen in the *Cirripeda:* these latter animals, however, by their articulated limbs, are yet removed out of the confines of the *Radiata,* although they become the first group in the *Annulosa,* — thus standing in precisely the same relation as the *Cephalopoda* do to the *Vertebrata.* We have now traced the chain of affinity into the annulose, or insect class; and it only remains to inquire how these latter are connected to the *Vertebrata,* or, in other words, how the animal circle is made out and closed. On this point, again, the labours of our predecessors

have removed all difficulty, and even doubt. The *Annelides* have the joints of their bodies, like the common earth-worm, disposed in rings, but yet they offer the extraordinary character of *red* instead of *white* blood: hence, they are always called red-blooded worms. There is, to be sure, no vestige of any internal support to the body, such as we have seen in the *Cephalopoda;* but every one must be struck with the resemblance which exists between a worm and an eel,—the one being, in form, almost the miniature of the other. This resemblance, moreover, is carried much further by certain eel-shaped fishes, which are destitute, not only of fins, but of eyes; while in others, as the genus *Myxine*, the vertebral column, or back-bone, is hardly to be distinguished. It is impossible, therefore, for this gradation to be more perfect. Every naturalist of the least repute has viewed the connection of the *Annelides* to the fishes in this light; and thus are all the classes of the animal kingdom united into one vast circle.

(8.) Of the three divisions of the *Mollusca*,—namely, the *Testacea*, the *Radiata*, and the *Acrita*,—it is obvious that the latter are the lowest in the scale of animal life; the superiority of the *Testacea* to the *Radiata* must also be admitted, when we come to compare the organisation of one with the other. The shells of the *Echinidæ*, the most typical group of the radiated animals, are certainly as beautiful and complicated in their construction — although not, perhaps, in outward appearance — as those of the *Testacea;* but we must look to the animals themselves. The *Echinidæ* show not the least indication of that form which belongs to vertebrated animals: although provided with short tentacula, which are supposed to assist them in removing from place to place, they yet move so slowly, that a snail, in comparison, may be said to run: thus the *Echinus*, although with tentacula,—which are supposed to perform the office of feet,—can scarcely remove itself a few inches; the snail, which has no foot or similar processes,

crawls on its belly, at what, in comparison, is a good round pace. The typical *Testacea* are all provided with eyes, however small, and with feelers; but the *Echinidæ* have none, properly so called; they are, in fact, decidedly lower in the scale of creation than the shell-fish; for, while the whole of the *Radiata* are destitute of eyes, those of the *Testacea*, in the pre-eminently typical division (the *Zoophaga*), and of the *Cephalopoda*, are generally very perfect, and always present. This accords exactly with what, from theory, we should have supposed: that the *Testacea*, being nearest allied to the typical *Vertebrata*, would consequently be more perfectly organised; while the *Radiata*, being cut off, as it were, from the *Vertebrata*, by the intervention of the *Annulosa*, become further removed from the great types of animal perfection, and, consequently, exhibit an inferior developement. The *Testacea* are, therefore, the most perfect of all the Mollusca.

(9.) Having now indicated, although with more brevity that we could have wished, the relative station of the testaceous *Mollusca*, both in regard to other animals and their own class, we shall direct our chief attention to the exposition of their natural and circular arrangement. Although we so far concede to the popular taste for conchology (as the "art" of arranging shells and other testaceous bodies is called) as to devote this volume exclusively to the testaceous *Mollusca*, we cannot sacrifice our conviction on the principles upon which these animals should be studied, or fall into the common method now in use of writing upon shells, independent of all consideration for the animals by which they are inhabited. To dignify any pursuit of this kind by the name of *Science*, seems to us quite misplaced; since it would be hardly more absurd to classify birds by the colour of their eggs, or beetles by the shape of their wings, than to propound an arrangement of shells, without a paramount regard to the animals which they cover. It is quite right that collectors of these elegant objects, who mix up with them shelly cases of insects

(*Cirripedes*) fragments of worms (*Annelides*), backbones of cuttlefish, gill covers of sea hares (*Aplysia*), &c., should arrange them in their cabinets upon some plan, and give them names; but no one will maintain that this amusement deserves to be called *science*.

(10.) One of the first zoologists of this country, in speaking of the utter ignorance which exists on the *natural* arrangement of the *Testacea*, and the high importance that belongs to the inquiry, makes the following remarks: — "At all events, it is not to those collectors who are solely intent on the external form of a shell, or the streaks of colour which ornament it, that the hope of discovering the true arrangement of the *Mollusca* can be held forth. The study of shells appears, indeed, to be indispensably necessary to the geologist; and, no doubt, the testaceous covering of an animal is always so intimately connected with its structure, that it would be unpardonable in the naturalist, who ought to leave nothing without investigation, to forget shells. But, on the other hand, when we call to our recollection the lamentable error committed by Linnæus and his disciples, in not following the example of our celebrated Lister in the arrangement of the *Mollusca*, we become convinced there was about as much hope of their ever arriving at the truth by the means they chose to adopt, as that a collection of the wings of different insects should ever instruct us fully in the natural history of the animals to which they belong. It is said that Klein formed an ornithological cabinet, in which the feet and beaks of birds were only to be seen; because, according to his notions, they were all the parts requisite for the proper arrangement of the feathered creation. He thought that it was possible to be a good ornithologist, without knowing the least of a bird but its beak and claw. We may, indeed, laugh at this; but, at the same time, we ought to inquire whether similar ridicule may not, with justice, be extended to those conchologists, who, having procured a shell, describe and classify it without deigning to bestow a single thought

on the nature of the poor animal which constructed it for its habitation.* A curious arrangement, as might have been expected, has come of this method of proceeding; for we have annulose animals† (or insects) united to true *Mollusca*, merely because they have shells; and true *Mollusca* separated from this division, merely because they have no shells. In some cases, even, as in the genus *Limax*, it is sufficient for the shell to be small, in order to set it wide asunder from animals of the same family: but it would be endless, as well as useless, to detail the violations of natural order manifested by Linnæus in his systematic arrangement of the mollusks, which have so truly constituted his stumbling block. It cannot, however, be denied, that, could we adopt his notion as to the nature of the animals, the principles upon which he arranged their testaceous coverings are excellent. To those who admire the splendour of the pencilling, the beauty of the enamel, and the variety of sculpture, which exist in shells, it might be depriving them of an innocent amusement, to object the trivial nature of their study as leading to no general results; but it may be as well to remind them, that, unless they add to their satisfaction and to their knowledge by studying the structure of the animals themselves, there is no more *science* in the disposition of their cabinets, than may appear in the tasteful arrange-

* A modern compiler, who has been at some pains to draw up what he considers some general observations on the "Principles of Conchology," very properly refrains from bestowing upon it the name of a science. "Conchology," as he observes, "is the art of arranging the protecting bodies of testaceous" (and he might have added of annulose) "animals, so as to enable us to recognise them promptly and certainly, without giving any attention to the animals which they have contained, or contain, or, at least, regarding this part as a matter of very minor importance" Independent of the assistance this "art" bestows to the studies of the geologist, he further observes, "it may almost be regarded as a study nearly idle and useless by all true zoologists." Nay, he continues, "it is really to this cause that conchology, properly so called, owes both the continuance of its existence, and the daily increasing efforts of enlightened naturalists, who endeavour to give it sure principles and rules." He omits to inform us, however, how these sure principles and rules can be attained in an "art" which absolutely rejects that solid foundation for them, upon which their true knowledge depends, — that is, a primary regard to the principles of the variation in these animals.

† The *Cirripedes*, or barnacles.

ment of porcelain on a mantelpiece. Separate the shell from the animal, and much less acquaintance with the natural system is to be derived from their inorganic covering, than Klein obtained of his birds, by seeing only their beaks and claws." *

(11.) The above sentiments on the insufficiency of the shell, in *all* cases, to determine its place in the natural system, we are free to confess, were held by us for many years. But the results of that analysis now given to the public, have materially modified, if not altered, this opinion. It is needless, perhaps, to repeat, that a primary regard must always be had to the nature of the mollusk itself; and that, without this knowledge, there are certain forms of *Testacea*, of which neither their natural tribes nor families can be conjectured, and which, for this reason, should always be kept apart. There are others, again, belonging to totally different families, or even orders, which are so alike in their shells, that conchologists place them in juxta-position.† But yet, on the other hand, there are numerous other families, where the modifications in the form of the shell are just as important, and even more so, than those of the animal. The molluscous system of Poli fully establishes this proposition, even though the innumerable proofs in its support, hereafter detailed, were rejected. The truth appears to be, that Nature, on the whole, has diversified the external aspect of these singular animals,—that is, their shells,—much more than she has their soft or more unsightly parts. If, therefore, she has thus bestowed all her beautiful embellishment upon the habitation rather than upon the inhabitant, we may at least conclude that the one is as essential to develope the plan she has pursued in her own system, as is the other. The diversity she has created on the shelly coverings of the typical *Testacea* is, beyond all comparison, greater

* Hor. Entom. p 240—244.

† Particularly the prototypes of the *Planaridæ*, as *Vitrina*, *Sigaretus*, *Chœlinotus*, &c.

than is to be found among their animals; but these latter must be well studied, *before* we can comprehend the leading types of form prevalent among the former. When this last discovery, if only in part, has been made, we shall find that the slightest modification in the shell is not without its meaning; and that, in nine instances out of ten, we may pronounce with as much confidence on its natural station in the scale of nature, as if we had actually dissected its animal.

(12.) A singular idea appears to be entertained by some writers, that the "art" of conchology, popularly so called, is only really serviceable to science, when viewed in connection with geology. But it may fairly be asked, how geology or any other branch of knowledge can be benefited by any aid which is not, in itself, built on sound and philosophic principles, which this "art" confessedly is not. It would be difficult to answer the question why one branch of zoology is to be separated from the others, and degraded into the hand-maiden of another science,—and that, too, of such very recent formation, that the most opposite opinions as to its very first principles are continually issuing from the press. It is not a little singular, also, that, while geologists appear to attach so much importance to mineral conchology, as it is termed, no author, as yet, has specifically written on the subject. In such a state of things, the attempts that are made to identify certain strata by the nature of the shells they may contain, should be ventured upon, in most cases, with very great caution. We are fully persuaded that many of those fossil shells termed by conchologists fluviatile, are decidedly marine; that the nature of others, from ignorance of their animals, can *never* be understood; and that a great number, now considered identical with existing genera, belong to groups altogether extinct. Until, therefore, all these suspicious points are cleared up, geologists will derive but very little comparative benefit by our modern systems of conchology, and will be frequently led to most erroneous conclusions. The "art,"

in fact, must merge into the science of MALACOLOGY, in which equal regard is paid both to the animal and the shell. It is then alone that geology will be really benefited. Our science will then repose upon a proper and philosophic basis, and in that capacity will be ready to aid those of her sisters who may solicit her services.

(13.) Our notices on the BIBLIOGRAPHY of the testaceous *Mollusca*, must be very brief, and chiefly confined to such as have a practical influence on the present state of science. This brevity will be the less regretted, since the subject has been so ably and fully gone into by Maton and Racket, in the seventh volume of the *Linnæan Transactions*. The foundation of this and every branch of zoological science was laid by the immortal Aristotle, who well discriminated all the leading groups of the typical *Testacea*, and was not inattentive to the habits and localities of the animal inhabitants. He separated the spiral univalves by the name of *Monothyra*, while he applied the term of *Dithyra* to the bivalves. It would have been as well if the moderns, in their multifarious and complicated nomenclature, had shown some little respect to the designations imposed by this commanding genius on the leading groups of the *Mollusca*; such defence would, at all events, have brought his name more frequently before us, and reminded the world how infinitely science was indebted to his labours. How much superior, also, is the simplicity of genuine classic names over those compounded in modern times, will be best seen by comparing those bestowed upon the bivalves, which are the *Dithyra* of Aristotle, and the *Malacozoaria Acephalophora* of M. de Blainville. It is too late, perhaps, to restore the entire nomenclature of the illustrious Stagyrite; but in this single instance we shall certainly prefer his designation of the bivalve *Mollusca* in preference to those of the moderns.*

* The term of *Acephala*, given by Cuvier, would be by no means objectionable, but that it sets aside the name of antiquity, and includes, moreover, numerous groups which have nothing in common with the *Dithyra* of Aristotle, except the want of a distinct head. To judge, indeed, from the writings and nomenclature of the French school, it would hardly be conjectured that such a man as Aristotle had ever existed.

(14.) Our celebrated countryman, Lister *, was the first naturalist, after the revival of learning, who made any decided improvement in this science, since he regarded both the animals and the shells; and his noble volume will be an imperishable record, both of his talents and his industry. The excellent figures of Rumphius†, published in 1711, are still valuable, as are likewise those of Gualtieri ‡, but neither of these writers can scarcely be said to have benefited the subject in any other way. D'Argenville's plates, although more elaborately finished, are very inferior to those of the last-named works; and it has been truly said, that what is really valuable in his book has been taken from Lister. The conchological labours of Klein, who was perpetually writing upon every branch of natural history, partake of the character which belongs to all, — a total want of genius. It was, in fact, reserved for Adanson §, the celebrated French traveller and naturalist, once more to revive malacology from the frivolous state into which it had been gradually sinking since the days of Lister: by studying both the animal and its shell, he prosecuted his researches on sound and philosophic principles; and hence it is, that his volume, although published in 1757, is highly valuable, while the "testaceous" arrangement of Linnæus is as if it had never been written, — or it is consulted only, at rare intervals, to determine a specific name. But Adanson confined himself to the shell-fish of Senegal; and it was not surprising that the scientific world, captivated by the simplicity of the Linnæan nomenclature, still continued attached to the plan of considering the *Testacea* merely in regard to their shells, of which innumerable species now began to pour in on the European cabinets. This,

* Lister. Historia, sive Synopsis Methodica Conchyliorum. London, one volume, folio; of which there are two editions, the last in two volumes. See *Prel. Discourse*, p. 24.

† Rumphius, G. E. Thesaurus Imaginum Piscium, Testaceorum, &c. Hagæ Comitum, 1739, folio.

‡ Nico. Gualteri. Index Testarum Conchyliorum. Flor. 1742, royal folio. The figures are the most artistical of any that we remember: the rotundity of the spiral shells is admirably represented.

§ Hist. Nat. des Coquillages du Sénégal. Paris, 1757, 4to.

doubtless, gave rise to the voluminous work of Martini and Chemnitz, which, although published between 1769 and 1788, and with figures exceedingly ill drawn, is, nevertheless, the most valuable, as a general work, we yet possess. It was soon after this time, however, that George Humphrey *, F.L.S., the chief commercial conchologist then living, gave to the world a small pamphlet, wherein he arranged the *Testacea* upon an entirely novel and very remarkable plan. As a system of conchology, this was both a sudden and a most extensive improvement upon everything of the kind which had hitherto been done. The arrangement, which will be subsequently adverted to, as far excels that of Linnæus, as Lister's exceeds that of Klein. There can be no doubt, in fact, that this little unpretending pamphlet, published in this country merely as an exhibition catalogue, found its way to France, and served as the main foundation, although unacknowledged, for the subsequent system of Bruguière, if not of Lamarck and Cuvier. It was, to write colloquially, the first quiet but thorough breaking of the ice, in which conchologists were bound up by the Linnæan system; and those who followed up the reformation, however justly we may praise them as *improvers*, cannot be invested with the more honourable distinction of *leaders*. It was, therefore, not in France, but in England, that the revolution against the meagre conchological school of Linnæus first originated. But, having said this, we can put forth no claims for our countrymen, on this head, during a subsequent period of nearly forty years. Montagu, indeed, must be named with honour, and Pennant's writings aided much to spread a taste for collecting shells; but beyond these, we recollect no others deserving special record. Meantime, a more correct knowledge of the molluscous animals was making rapid progress on the Continent. Those illustrious and admirable anatomists, Poli in Italy, and Cuvier in France,

* Museum Calonnianum. — Specification of the various Articles which compose the magnificent Museum of Natural History, collected by M. de Calonne in France. Anonymous. London, May 1. 1797.

were prosecuting their researches with indefatigable industry; while Bruguière, and subsequently Lamarck, were no less occupied in describing and arranging the *Testacea;* meantime, faint attempts, in the shape of Introductions, to keep alive Linnæan conchology, were all that appeared in England on this subject. The labours of Bruguière were unfortunately terminated prematurely by death, but those of his illustrious friend Lamarck were continued up to within these few years. His masterly and incomparable work, wherein all his labours on the invertebrated animals are concentrated, are too well known to be expatiated upon in this place, since it is in the hands, or should be, of almost every zoologist who studies those classes. The investigations of Poli, even more elaborate than those of Cuvier, have been given to the world more slowly, and in such an expensive form, as to deprive them of half their utility.* Not so with those of the celebrated Cuvier. The *Règne Animal,* a book accessible to all purchasers, contains the essence of all his labours on the *Mollusca,* but, unfortunately, so much abridged, that the student is frequently more perplexed, than satisfied, on the point he is searching for. His more detailed memoirs are scattered through innumerable volumes of foreign transactions, where they lie completely hidden from every-day reference, although their intrinsic and permanent value would fully warrant their being collected and printed in a cheap volume.† In estimating the merits of these three great men,—Poli, Cuvier, and Lamarck,—in regard to their arrangement of the testaceous *Mollusca,* it may be stated, that the first confined his system entirely to the animal, giving to it a different name to that of the shell; so that, if the animals of two conchological genera (as *Avicula* and *Lima*) were nearly

* Poli. Testacea Utriusque Siciliæ, eorumque Historia et Anatomia, 2 vols. royal folio. Parmæ, 1790—5.

A Supplement, by Stephanus della Chiaje, forming another volume, was published at Naples in 1833.

† A few copies of these *Mémoires,* with their plates, were struck off separately, and published in one 4to. volume, Paris, 1817; but this is now become so rare as to be unprocurable, excepting by chance.

alike, they were placed, in his system, in one and the same genus. Cuvier has altogether avoided this strange mode of procedure; but an inspection of his system will bear us out, we think, in our opinion that he has placed far too great a stress on the modes of respiration, and paid too little attention to the shell, no less than to the animal; while the great error of Lamarck appears to have been that of giving to the shell, and more especially the hinge of bivalves, a greater regard than he bestows upon the animal. The system of M. de Blainville, indeed, professes to remedy these defects; but we can discern in it little that is new, beyond innumerable compound Greek names, proposed for groups already established by his predecessors, and which are only calculated to overturn all existing nomenclature, without adding anything practical to the advance of science.

(15.) Whatever may be the cause, certain it is that nearly all that is now valuable in malacology has emanated from the Continental naturalists. Besides those just enumerated, the unwearied zeal of the French circumnavigating naturalists, more especially M. Quoy, has added to this science not merely a host of new shells, but — what is far more valuable — innumerable facts, of the highest importance, regarding their animals. We only regret that the price of these splendid publications, and the few copies of them yet in this country, have prevented us, in all instances, from profiting from these most valuable materials. The only one of our countrymen who has pursued the same path of inquiry, and on the same philosophic principles, was our late friend, the Reverend Lansdown Guilding, who, from his official residence in the West Indies, had the enviable opportunity of examining, and the rarely united talents of drawing, dissecting, and describing, the soft *Mollusca* of the Caribbean seas. To him is science indebted for a knowledge of the animals of numerous terrestrial and many marine shells; and the institution, on the most solid basis, of several natural genera. These invaluable researches, too little appreciated by our conchologists,

in their zeal for describing new species, and too little known to the scientific world, from being scattered in detached papers, or unpublished, are all incorporated and acknowledged in this volume.* To this accomplished zoologist and exquisite artist are we indebted, among many other things, for the discovery of the extraordinary genus *Herpa;* and for drawings of the animals of *Oliva, Volutella, Marginella, Triton,* and *Trochella;* as also of several other groups, originally characterised from the shells alone, but now confirmed by the difference of their animals. The name of Mr. Lowe, the natural historian of Madeira, deserves honourable mention in this place, as connected with the illustration of many interesting facts on the *Mollusca* of that island. A most magnificent, but extravagantly expensive, work on the land and freshwater shells, was commenced, several years ago, by the late baron de Ferussac.† As it was patronised by Royalty, some hopes were entertained of its completion, notwithstanding the grand scale it set out upon; but the undertaking was evidently too vast for the very moderate abilities of its projector; the parts came out less and less regularly, until, after it had cost the subscribers near 50*l.*, it was (virtually) given up, and the author died. This striking example is surely sufficient to convince any sober judging person of the utter impracticability of completing a General Conchology, or of carrying it on beyond a few numbers. It is, in fact, a physical impossibility for any one or five men to accomplish such a work in the ordinary term of human life; and even if brought to a termination, unless conducted on the most economic scale, would involve an outlay to the projectors, and an expense to the public, which the latter, at least, would never incur. We are, in truth, heartily set against all these magnificent undertakings: they are absolutely detrimental to science;

* A large collection of highly finished drawings, and several MSS., are now in the possession of Mr. Guilding's late widow.

† Ferussac. Hist. Nat. générale et particulière des Mollusques Terrestres et Fluviatiles, 27 parts, published, Paris, 1819—33.

for they confine the materials of knowledge and of study within the narrow limits of the select few (generally wealthy amateurs), to the exclusion of all who cannot expend 400*l.* or 500*l.* upon a zoological library. We cannot but admire the zeal of their projectors, — for such works never produce profit, and generally bring a heavy loss,— but we think it a zeal misplaced. What is now most wanted, is a collection of plates of shells, to supply the deficiencies of the series in the *Tableau Encyclopédique et Méthodique* *, and printed uniformly. The series in question contains nearly 300 plates, and is the very best which the naturalist can possess. We have constantly referred to it, as being more within the pecuniary reach of the student, and as being far more accurate in the figures, although uncoloured, than that of Martini and Chemnitz ; and these latter are therefore only quoted for species not contained in the other. The figures in Wood's *Catalogue* are often very good ; but the arrangement is so confused, and often so erroneous, that the nomenclature, in its present state, can seldom be quoted as an authority.

(16.) In regard to SYSTEMS and ARRANGEMENTS of the testaceous animals, the only attempt that has ever yet been made towards the natural disposition of this extensive class, is that indicated in the *Horæ Entomologicæ*. The ingenious author, however, candidly acknowledges his inability even to point out the primary divisions; although he has ventured, and, as we think, has partially succeeded, in tracing the links of affinity by which the testaceous *Mollusca* are connected, on one side, to the *Acrita*, or polypes, and, on the other, to the vertebrated animals, by means of the *Cephalopoda*. Of arrangements made without any ulterior object of illustrating the general harmonies of nature, and therefore artificial †, there are several ; the best being those

* With these plates, and Lamarck's volumes of the *Hist. Nat. des Animaux sans Vertèbres*, the conchologist will be at no loss to arrange an ordinary collection of shells, and name by far the greater portion of the species. The excellent *Manuel de l'Hist. Nat. des Mollusques* of M. Sander Rang should also be procured, on account of the valuable notices it contains on the structure of the animals.

† See Geography and Classification of Animals, p. 125.

of Humphrey, Lamarck, and Cuvier. The two first of these will therefore be exhibited in their details; the latter having already been placed before the reader in a former volume. Although that of Lamarck, by common consent, has been preferred by nearly all zoologists, it is but justice to the distinguished author of the *Règne Animal*, to designate his early *Mémoires* upon these animals as fully entitling him to the high reputation his anatomical talents have so justly acquired for him in other departments. They are materials upon which all true knowledge of the *Testacea* must repose.

(17.) The conchological arrangement of Humphrey, already spoken of, will now be detailed, so far, at least, as regards the names of the genera; since their definitions were never published. To show how intimately very many of these accord with those of Lamarck, we have, in almost every instance, added the corresponding genus of the latter. The ingenious author had such a conviction that the fluviatile and terrestrial genera should be kept distinct from the marine, that he places them in separate divisions.*

Class TESTACEA.

Order I. MARINE.

Division I. Univalves.	
Serpula *Linn.*	
Dentalium *L.*	
Patella *L.*	
Larva.	Fissurella *Lam.*
Crypta.	Crepidula *Lam.*
Calyptra.	Idem *Lam.*
Galerus.	Calyptræa *Lam.*
Pedum.	Spirula *Lam.*
Nautilus *L.*	
Argonauta *L.*	
Bulla *L.*	
Licium.	Ovula *Lam.*
Cypræa *L.*	
Dactylus.	Marginella *Lam.*
Oliva *L.*	
Conus *L.*	
Melo.	*Broderip.*
Voluta *L.*	
Musica.	Voluta *Lam.*
Harpa.	*Lam.*
Dolium.	*Lam.*
Casida.	*Lam.*
Haliotis *L.*	
Haliotoidea.	Stomatia *Lam.*
Auris Veneris.	Sigaretus *Lam.*
Neritoidea.	{ Ianthina, &c. *Lam.*
Uber. Lunatus.	Natica *Lam.*
Nerita *L.*	
Auris Mustelæ.	Tornatella *Lam.*

* The author, with that modesty which was his peculiar characteristic, thus expresses himself: — "The editor hopes that his confession of being but little acquainted with the learned languages will be received as an apology for such improprieties in the generic or specific names as he fears will be found." — *Museum Calonneanum*, pref. p. v.

Turbo *L.*	
Eutropia.	Phasianella *Lam.*
Scala.	Scalaria *Lam.*
Terebra.	*Lam.*
Obeliscus.	Trochus *Linn.*
Cochlus.	Cidaris *Sw.* / Marmarostoma.
Senectus.	*Sw.*
Elenchus.	*Sw.*
Physeter.	Solarium *Lam.*
Apiculum.	Trochus *Lam.*
Trochulus. / Trochus.	Monodon *Lam.*
Sol.	Tubicanthus *Sw.*
Onustus.	*Sw.*
Pygmæa.	Columbella *Lam.*
Pyrum.	Pyrula *Lam.*
Haustrum.	Purpura *Lam.*
Hystrix.	Ricinula *Lam.*
Bulbus.	Rapella *Sw.*
Acus.	Terebra *Lam.*
Clava.	Cerithium *Lam.*
Cassidula. / Ficus.	Pyrula *Lam.*
Rhombus.	Fusus, &c. *Lam.*
Rana.	Ranella *Lam.*
Buccinum.	Triton, &c. *Lam.*
Turris.	Turritella *Lam.*
Colus. / Fusus.	Fusus *Lam.*
Cuma.	Fusus *Lam.* / Fasciolaria *Ib.*
Mitra.	*Lam.*
Murex.	Scolymus *Sw.*
Rapum.	Turbinella *Lam.*
Alatus.	Strombus *Linn.*
Strombus.	Pterocera *Lam.*
Triplex. / Purpura.	Murex *Linn.*
Rheda.	Hyalia *Lam.*

DIV. II. BIVALVES.

Pinna *L.*	
Mytilus *L.*	
Solen *L.*	
Margaritifera.	Avicula *Lam.*
Vulsella.	*Lam.*
Placuna.	*Lam.*
Cepa.	Anomia *Linn.*
Lampus.	Terebratula *Lam.*
Mactra *L.* / Trigonella.	Mactra *Linn.*
Tellina *L.*	
Cuneus.	Donax *Linn.*
Pectunculus.	Venus *Linn.*
Cardium *L.*	
Trapezium.	Chama *Linn.*
Tridacna.	*Lam.*
Glycymeris.	*Lam.*
Arca *L.*	
Pecten.	*Lam.*
Ostrea *L.*	
Lacinia.	Chama *Lam.*
Spondylus *L.*	

DIV. III. MULTIVALVES.

Pholas *L.*	
Lepas *L.*	
Cornucopia.	Lepas *Linn.*
Balanus.	
Chiton *L.*	

ORDER II. FLUVIATILE.

DIV. I. UNIVALVES.

Catillus. / Neritella.	Neritella *Lam.*
Pomus.	Ampullaria *Lam.*
Vesica.	Lymnia. / Melania *Lam.*
Ligula. / Turricula.	Melania *Lam.*

DIV. II. BIVALVES.

Barbata.	Unio *Lam.*
Scapha.	Iridina? *Lam.*
Mya.	Unio *Lam.*
Nux.	Cyclas *Lam.*
Capsa.	?

ORDER III. TERRESTRIAL.

Sylvicola.	Cyclostoma *Lam.*
Helix *L.*	
Lituus.	Cyclostoma? *Lam.*
Cistula.	Cyclostoma.
Bombyx.	?
Otis.	Auricula *Lam.*
Chersina.	Achatina *Lam.*
Lendix. / Pupa.	Pupa *Lam.*

(18.) As a purely conchological system, this was unquestionably the best and the most original of any that had appeared since the revival of learning. It was published in 1797, nearly twenty years before the first of Lamarck's volumes appeared.* That it was well known to the latter can hardly be doubted, when we see no less than ten genera similarly named by both; and that almost every genus of Lamarck's univalves are found in this list, under different, but less classical, names. Of univalves, Humphrey has 87, contained in the single collection of which his book is a catalogue. How many more he had determined to name, does not, of course, appear; but the total number of Lamarck's is but 96, for the whole of the testaceous gastropods.

(19.) Lamarck's system, so far as regards the animals now before us, may be thus briefly stated. He arranges the whole group under the two classes of — I. *Conchifera;* and, II. *Mollusca*. The first contains the bivalve shell-fish, and is again divided into two orders: one of these is called *Conchifères dimyaires*, the interior of the shells presenting *two* muscular impressions, separated and lateral; while in those of the second order, or *Conchifères monomyaires*, there is but one muscular impression, placed nearly in the centre, — the muscle itself being single, and which appears to run through the body of the animal. Each of these great divisions of bivalves contains several others, denominated sections, chiefly differing in the structure of their feet.

ORDER I. CONCHIFE'RES DIMYAIRES.

SECTION I.	Mya.	Amphidesma.
Aspergilium.	Anatina.	Corbula.
Clavagella.		Pandora.
Fistularia.	SECT. II.	Saxicava.
Septaria.	*Conch. tenuipedes.*	Petricola.
Teredina.	Lutraria.	Venerirupis.
Pholas.	Mactra.	Sanguinolaria.
Gastrochæna.	Crassatella.	Psammobia.
Solen.	Erycina.	Psammotæa.
Panopæa.	Ungulina.	Tellina.
Glycimeris.	Solenimya.	Tellinides.

* The first volume of the *Hist. Nat. des Animaux sans Vertèbres* bears the date of March, 1815.

Corbis.
Lucina.
Donax.
Capsa.
Crassina.

Sect. III.
Conch. lamellipedes.

Cyclas.
Cyrena.
Galathea.
Cyprina.
Cytherea.
Venus.
Venericardia.
Cardium.
Cardita.
Cypricardia.
Hiatella.
Isocardia.
Cuculæa.
Arca.
Pectunculus.
Nucula.
Trigonia.
Castalia.
Unio.
Hyria.
Anodon.
Iridina.

Sect. IV.
Conch. ambigus.

Diceras.
Chama.
Etheria.

Order II. CONCH. MONOMYAIRES.

Section I.

Tridacna.
Hippopus.
Modiola.
Mytilis.
Pinna.
Crenatula.
Perna.
Malleus.
Avicula.
Meleagrina.

Sect. II.

Pedum.
Lima.
Plagiostoma.
Pecten.
Plicatula.
Spondylus.
Podopsis.
Gryphæa.
Ostrea.
Vulsella.
Placuna.
Anonica.

Sect. III.
Branchiopoda Cuv.

Sphærulites.
Radiolites.
Calceola.
Birostrites.
Discina.
Crania.
Orbicula.
Terebratula.
Lingula.

(20.) To his second great division, Lamarck restricts the title of *Mollusca:* these he again subdivides into the five following orders: — 1. The *Pteropoda,* which forms a part of our *Cephalopoda.* 2. The *Hydrobranchia,* which includes the *Nudibranchia, Scutibranchia,* and *Tectibranchia* of Cuvier; together with the genera *Onchidium, Parmacella, Limax, Testacellus,* and *Vitrina:* these genera he places in his section *Pneumobranchia,* and makes them the passage to his *third* order, or the *Trachelipodes,* in which all the univalve shells are placed. The *fourth* order is composed of the *Cephalopoda,* or cuttlefish; and the *fifth* contains the *Heteropoda.* The genera belonging to each of these orders are as follows: —

Order I. PTEROPODA.

Hyalæa.
Clio.
Cleodora.
Limacina.
Cymbulia.
Pneumodermon.

Order II. GASTEROPODES.

Section I.

Glaucus.
Eolis.
Tritonia.
Scyllæa.
Tethys.
Doris.
Phyllidia.
Chitonellus.
Chiton.
Patella.
Pleurobranchus.
Umbrella.
Parmophora.
Emarginula.
Fissurella.
Pileopsis.
Calyptræa.
Crepidula.
Ancylus.
Acera.
Bullæa.
Bulla.
Aplysia.
Dolabella.

Sect. II.

Onchidium.
Parmacella.
Limax.
Testacella.
Vitrina.

Order III. TRACHELIPODES.

Section I.
Les Phytiphages.

Helix.
Carocolla.
Anastoma.
Helicina.
Pupa.
Clausilia.
Bulimus.
Achatina.
Cyclostoma.
Planorbis.
Physa.
Lymnæa.
Melania.
Melanopsis.
Pirena.
Valvata.
Paludina.
Ampullaria.
Navicella.
Neritina.
Natica.
Ianthina.
Sigeretus.
Stomatella.
Stomatia.
Haliotis.
Tornatella.
Pyramidella.
Vermetus.
Scalaria.
Delphinula.
Solarium.
Rotella.
Trochus.
Monodonta.
Turbo.
Planaxis.
Phasianella.
Turritella.

Sect. II.
Les Zoophages.

Cerithium.
Pleurotoma.
Turbinella.
Cancellaria.
Fasciolaria.
Fusus.
Pyrula.
Struthiolaria.
Ranella.
Murex.
Triton.
Rostellaria.
Pteroceras.
Strombus.
Cassidaria.
Cassis.
Ricinula.
Purpura.
Monoceros.
Concholepas.
Harpa.
Dolium.
Buccinum.
Eburna.
Terebra.
Columbella.
Mitra.
Voluta.
Marginella.
Volvaria.
Ovula.
Cypræa.
Terebellum.
Ancillaria.
Oliva.
Conus.

Order IV. CEPHALOPODES.

Section I.
Testaceous Cephalopoda.

Belemnites.
Orthocera.
Nodosaria.
Hippurites.
Conilites.
Spirula.
Spirolina.
Lituola.
Renulina.
Christellaria.
Orbiculina.
Miliola.
Gyrogona.
Melania.
Rotelia.
Lenticulina.
Placentula.
Discorbis.
Siderolites.
Polystomella.
Vorticialis.

Nummulites.	Baculites.	Sect. III.
Nautilus.		*Ceph. Cepiaria.*
Ammonites.	Sect. II.	Octopus.
Orbiculites.	*Ceph. Monothalama.*	Loligopsis.
Ammonoceras.	Argonauta.	Loligo.
Turrilites.		Sepia.

Order V. HETEROPODA.

Carinaria.	Pterotrachia.	Phylliroe.

(21.) The system of M. Cuvier differs, in many respects, from the above. The *Mollusca* form the second great division into which this admirable anatomist divides the animal kingdom. These he distributes under six principal classes: 1. *Cephalopoda,* or cuttlefish; 2. *Pteropoda,* or clios; 3. *Gasteropoda,* an immense and heterogeneous assemblage, which we shall presently notice in detail; 4. *Acephala,* or bivalve *Testacea,* at the end of which he introduces the tunicated *Mollusca* (*Tunicata* Sav.); 5. *Branchiopoda,* or anomian shells; 6. *Cirripedes,* or barnacles. The great variety of animals brought together in the third order, *Gasteropoda,* obliges our author to divide it into others, the names and contents of which are as follows: —1. Pulmonia, contains the slugs and snails, both terrestrial and fluviatile. 2. Nudibranchia, includes all the naked marine *Testacea* without shells, — as *Triton, Doris, Thethys,* &c. 3. Inferobranchia, consists but of two genera, *Phyllidia* and *Diphyllidia.* 4. Tectibranchia, comprehends the *Bulla* family and the *Aplysia.* 5. Heteropoda, embraces the *Firoles* and the *Carinariæ.* 6. Pectinibranchia: under this order, arranged in sections, are placed the whole of the *Trochus* and *Turbo* families, together with the greatest part of the marine univalve *Testacea.* 7. Tubulibranchia, is limited to the genera *Vermetus, Magilis,* and *Siliquaria.* 8. Scutibranchia, contains *Haliotis, Fissurella,* and *Emarginula*: while the 9th and last order, Cyclobranchia, consists but of *Patella* and *Chiton.* To go into further detail will be needless, since the student will at once arrive at a general idea on the contents of these groups, by the indications already given.

(22.) In both these latter methods of classifying the *Testacea*, there is much to approve and much to dissent from. It is clear that neither of these naturalists, however great their merits undoubtedly are in other respects, have paid any attention to the difference between *analogy* and *affinity:* nor have they aimed at anything beyond producing a *simple* scale or line of connection from one group to another. Now, as no such *simple* series exists in nature, — whose relations of affinity are always double, and generally treble, and whose analogies are interminable, — it follows, as a matter of course, that both have completely failed in laying down a simple graduated scale of the objects before them. Hence, as the groundwork of both systems is founded in error, no apology is necessary for rejecting them, particularly when the object sought for is the discovery of the natural arrangement. It is time, however, to leave the systems of others, and to lay before the naturalist some details of that here proposed.

CHAP. II.

ON THE TESTACEOUS MOLLUSCA IN GENERAL, THE PRIMARY DIVISIONS, AND THEIR ANALOGIES TO THE VERTEBRATA AND ANNULOSA.

(23.) The testaceous mollusks, or shell-fish, with few exceptions*, are all marine, or, at least, aquatic animals, soft and slimy in their nature, and without articulated limbs, so that such as can move about, crawl upon their belly, or swim in the water by means of the fin-shaped lobes of their mantle. Independent of their peculiar anatomical structure, and merely looking to external characters, the most perfect of the testaceous

* Some of the parasitic groups, and the land shells, or slugs.

tribes are at once known, either by being covered with a hard shell, or, if without this protection, by having white blood, and being destitute of any processes which perform the office of feet. Many, indeed, are fixed to the surface of rocks, and other substances, where they remain during life; while others bore for themselves internal cavities, or cells, in which they take up their permanent habitation; while the least organised are parasitic. The similarity of some of the naked *Testacea* to the *Annelides*, or sea-worms, is so great, that the older naturalists classed them together; and even to this day we find a whole division mixed up with the annulose *Vermes*, or true intestinal worms. Let the student, however, bear in mind that the animals of which we are now speaking have neither joints to their bodies or limbs, nor any processes, by which they can crawl; and that their blood is *white*, and not, as in the *Annelides*, *red*. Furthermore, the testaceous *Mollusca* never assume the shape of the polypes; nor do they possess that radiated form and arrangement of filaments, which give such a peculiar aspect to the *Radiata*. By these circumstances, therefore, the observer may discriminate, in ordinary cases, the characteristic marks of even the aberrant or less perfect *Testacea*; while he can be in no doubt as to those which constitute the types. The perfection of the class is seen in those animals whose body is protected by a hard calcareous covering, or shell, either in the form of a twisted or convoluted cone, variously modified, or composed of two principal valves or pieces, more or less flattened, and united by a cartilaginous hinge. These shells are generally ornamented with a variety of colours, and are frequently polished, on their external surface, in the most beautiful and perfect manner, by the animals themselves. The single shells are called *Univalves*, and such is the periwinkle and snail; while the double are termed *Bivalves*, and are exemplified in the oyster and the cockle. As nature, however, proceeds from one to the other of these groups by gradations of structure, we consequently

find a few bivalves which assume the appearance of univalves; and others which, from the valves being more than two, were called by Linnæus *Multivalve* shells. This term the great Swede applied not only to those animals which really belonged to the *Testacea*, but to the *Cirripedes*, or barnacles, which have nothing to do with shells, properly so called. The term, therefore, is altogether objectionable, and will not here be employed.

(24.) Such are the leading external distinctions of the class of animals now before us. Their typical characters are three; two positive, the other negative. The first is that of crawling upon their belly, yet without feet; the second is their being covered with a beautiful calcareous shell, which is their constant habitation, and which they have the power of enlarging, to suit the progressive growth of their soft bodies; the third is, that, if deprived of this covering, they have not the least vestige of rings or joints on their bodies: the mouth, indeed, may be circular, and even the branchia, but this is the only analogy they have to the *Radiata*. In proportion as nature recedes from this typical eminence, the structure of the shell becomes imperfect, until, in the aberrant groups, the animal is either naked, or is but partially protected by such a covering.

(25.) The *Testacea*, considered anatomically, may be described as soft inarticulate animals, almost always breathing by branchia, or lungs, which vary, however, in the most singular diversity of ways both as to form and situation; this variation, moreover, takes place in groups so closely related to each other in all other respects, that it is perfectly clear no natural arrangement can be founded upon the organs of respiration. The least organised, in fact, such as the *Planariæ*, &c., have no branchia whatever; so that they only possess two of the characters of the class,—namely, a flattened disk or disks, which act as a foot, and a total absence of joints in their body. Their blood is white, and its circulation, observes Cuvier, is always double; that is, their pul-

monary circulation describes a separate and distinct circle. As for their manner of reproduction, it is even more variable and diversified than their mode of respiration. In some, as with *Gasteropoda*, there is a head with tentacula and eyes, either slightly or very fully developed; while in the *Dithyra*, or bivalves, all these parts are wanting. Nearly all, however, have a developement of the skin which covers their body, which bears more or less resemblance to a mantle: but even this assumes innumerable shapes; — sometimes it is dilated in the form of wing-like fins; in others, as the carnivorous *Gasteropoda*, it becomes a syphon by which the animal breathes. In the naked *Testacea*, the mantle is simply membranaceous, coriaceous, or fleshy. It is, in fact, utterly impossible to give such a general detail of this diversified class, either in respect to external or internal anatomy, as will not be subject to innumerable exceptions at every step. All the modes of mastication and deglutition, as Cuvier says, are found among these animals; their stomachs are sometimes simple, sometimes multiple. They also present examples of all the modes of generation; and the same learned anatomist confesses that "these varieties of the digestive and generative processes are found in the same order, and sometimes in the same family."* Hence it inevitably follows, that any system founded solely on any one or more of these anatomical considerations, is sure to be not only unnatural, but perfectly unintelligible to the great bulk of naturalists, who are referred to the soft parts of an animal which they never saw, and cannot procure. In regard to the nervous system, Mr. MacLeay has well observed, that "the most general notion we can form, at present, of the nervous system of the *Mollusca*, is, that the medullary collar, in the more typical groups, must always, in its circumference, contain four ganglions, which may either be united two and two, as it is probable they are in the

* Griff. Cuv. p. 4.

Acephala (*Dithyra*), or all four together, as in *Tritonia.* The brain is always composed of two of these lobes, which are generally connected, as in *Aplysia,* or sometimes separate, as in *Haliotis* and *Patella:* the remaining two ganglions of the collar send off nerves to the organs of respiration, &c., and are either united together, as in the common slug and *Patella,* or are separate, as in *Aplysia.*" It is time, however, to quit these generalities, and enter into more definite details.

(26.) A rapid survey of the general peculiarities of the class will not, however, be here misplaced. We have said that these animals have no distinct feet, or any organs which, by forming appendages to their body, supply their want. It is, however, customary — although the appellation is certainly incorrect — to call that part of the body which is next to the ground, and which is generally smooth and flattened, *the foot,* when, in fact, it is merely the belly, assuming only the office of a foot, and the shape of a sucker: by alternately contracting and extending this part, the animal moves forward, — slowly, indeed, but very surely. The aquatic species are able to crawl on marine rocks, even when the sea is greatly agitated; and every one knows the tenacity with which a slug will adhere to the substance from which we attempt to remove it. This is at once explained by the smooth disc of the belly acting as a sucker, like the tail of the leech. This mode of progression is almost universal among the *Gasteropoda,* or univalve shell-fish; but, in the bivalves, the body of the animal is frequently lengthened behind, so as to assume a much more analogous appearance of a foot than what we find in others. The common cockle is one of the best, as it is one of the most familiar, instances of this structure. Those who have watched these animals at the ebb of tide, know that they *leap* very frequently; but on their method of doing this two opinions have been given: some maintain that the foot, which, when protruded, forms a sharp angle, is the chief organ made use of; while others assert that this motion is caused by the sudden

shutting of the shelly valves, which produces a jerk. In some very few instances among the typical *Testacea*, as in the genus *Ianthina*, or oceanic snail, the animal has a cellular organ attached to the belly, by which it floats on the surface of the ocean, or sinks to the bottom, at its own pleasure. The power of swimming, however, is chiefly found among the aberrant groups, such as the cuttlefish (*Cephalopoda*), the tritons (*Nudibranchia*), and the *Tectibranchia:* the first of these may really be said to possess *fins;* while the naked tritons, no doubt, use the appendages of the body for the same purpose. The power of adhesion is also differently bestowed: in the cuttlefish and *Planariæ*, it resides in the innumerable suckers which terminate the arms of one, and are placed on the under side of the other. In the limpet (*Patella*), the ear-shell (*Haliotis*), and the chiton, it originates in the excessive breadth of the disk upon the belly, which covers a surface equal to that of the whole animal and its shell: so firmly, indeed, do these genera adhere to the rocks or other substances upon which they are found, that they can only be separated by great force. It is among the limpets that we find the power of locomotion at its lowest ebb; for they seldom remove far from the spot on which they were born; and many, from the shape of the shell corresponding to the surface of the rock, appear never to have done this: finally, in the genus *Hipponix*, we arrive at a positive certainty that the animal is fixed, because it adheres by a separate distinct plate, which thus, in point of fact, renders it a bivalve shell. Attachment, however, is much more prevalent among the bivalves, where we have entire families fixed to marine substances, either by one of these valves, as the oysters, or by a packet of strong fibrous threads. The attached genera are much less numerous than the others, and are affixed in different ways. Some, like the muscles (*Mytilus*), are merely connected into little bunches or families, by slender and scattered threads, strong enough to keep them together; others, as the *Pinnæ*, or wing-

shells, are provided with a thick tuft of silky hairs, called a *byssus,* which issues from one side only of the shell, the other end being firmly attached to marine bodies. In both these families, however, there is still some slight locomotive power left; for, although the animal does not, and probably cannot, quit the spot by disengaging its byssus, and mooring itself to another station, still it is not rendered absolutely motionless: the waves can move the shell backwards and forwards, and the fish may be compared to a horse or other animal fastened by a very short rope, which, nevertheless, permits him to move his body and limbs. In the *Pholas,* we have the next step towards an absolute extinction of the power of moving. These shell-fish have no byssus, nor are they affixed by any other method; yet, soon after birth, they perforate the substance upon which they have been deposited by the parent, and excavate for themselves deep burrows, or caves, exactly of the circumference of their own shells; and in these hollows they take up their permanent residence. It is not absolutely ascertained, indeed, that these boring *Testacea cannot* quit their first habitation for another; but there are many reasons to authorise the supposition that they live and die in the same which they excavated when young, and which they have the power of enlarging as they increase in size. Within such a narrow compass, it is obvious that the *Pholas* is more a prisoner than the *Pinna* or the *Terebratula,* because the walls of its habitation keep it immoveable, so that even the agitation of the waves cannot give it that undulating motion enjoyed by the byssiferous families. Finally, we come to such as are absolutely cemented by one of their valves to rocks or stones, or to each other: many of the oysters are of this description; but the most conspicuous are the different species of *Chama* and spondyles; several of which have the entire surface of one valve fastened by a calcareous deposition to rocks, pieces of floating timber, and to the bottoms of ships. It is, consequently, in these families, and in the worm-shells,

that we have the most perfect examples of the sedentary *Testacea*.

(27.) Although the head, where it exists, of the *Testacea*, is very different from that of vertebrated and annulose animals, — inasmuch as it is not separated from the body by a neck, — it is yet to be distinguished, in many groups, by the presence of tentacula, or feelers, and by two or four black dots, which are generally considered to be the organs of sight: in proportion as we advance from the *Planariæ* on one side, and from the chitons on the other, towards the cuttlefish, we find the head and the eyes gradually assuming that definite shape and structure which are so characteristic of the vertebrated animals. Some of the tritons (*Nudibranchia*), and all the bivalve shell-fish (*Dithyra*), have no indication of eyes, nor have the latter any obvious head; but in the *Gasteropoda*, or univalves, both begin to appear. We see this in the garden snail, and in all the freshwater and marine animals of this tribe. In the *Strombidæ* and the *Volutidæ*, the eye is nearly as perfect as that of the cuttlefish. From this group, however, nature again recedes; and in the *Pteropoda*, although the general form is preserved, the head is once more confounded with the body, and the eyes disappear.

(28.) On the habits, food, and geographic distribution of the *Testacea* we can say but little which is applicable to all. The great majority are aquatic and marine; but two or three extensive families are found only in fresh water. The land shells are exceedingly abundant in species, and the gastropod worms are parasitic in or upon other animals. It may be here remarked, that all the bivalves (*Dithyra*) are aquatic, but that the univalves inhabit the different situations just enumerated. The food of all these creatures varies according to their own particular races. A large number (forming the phytophagous gastropods) feed almost only upon living vegetables, either terrestrial or aquatic, — as the snail of our gardens, and the periwinkle of our

coasts; but a still greater assemblage are carnivorous, — devouring not only living, but dead, animals, and even attacking other tribes of their own class. It would be interesting to know in what manner nature has provided for the sustenance of such as are permanently affixed to one spot. Some of these have divers methods of exciting little currents in the water, by which means fresh portions of it are brought to the mouth, along with which such minute animals or fragments of vegetables as are adapted for food are secured. The branchipodous bivalves, like the *Terebratulæ*, although sedentary, are provided with long fringed processes, which are, no doubt, employed to capture their prey, in a similar manner to the arms of the *Cirripedes*, or barnacles; while the cuttlefish (*Cephalopoda*) and the *Tritonia* swim about in search of marine animals weaker than themselves. In regard to their geographic distribution, much might be said, did we not fear being drawn into longer details than our space would permit. It will be only necessary to observe in this place, that the geographic range of the *Testacea* is not so wide or uncircumscribed as the generality of authors assert. Tropical latitudes, as usual, display a greater variety of species, and a larger number of individuals, than those seas which lie under temperate or frigid skies. The *Testacea* of Europe are as distinct from those of America, as the latter are from those of Australia, Africa, or Asia. We have already illustrated this fact in that part of our series devoted to the geographic distribution of animals; and it may be safely asserted that the grand features of zoological geography are as conspicuous in this class of animals, as in any other.

(29.) The great natural divisions of the testaceous *Mollusca* appear to us to be these: — The *first*, or pre-eminently typical, are unquestionably the GASTEROPODA, or spiral univalves, whether we consider the comparative perfection of their internal or their external structure. The *second*, or sub-typical class, is com-

posed of the DITHYRA of Aristotle, or the bivalves, whose structure is less perfect, but which are in like manner protected by a regularly formed, and often richly coloured, bivalve shell. The *third*, or aberrant group, as usual, comprehends three: 1. The NUDIBRANCHIA of M. Cuvier, or the naked *Gasteropoda;* 2. The PARENCHYMATA, or intestinal *Testacea;* and, 3. The CEPHALOPODA, or cuttlefish. We shall first slightly glance at the leading characters of each of these classes, and then endeavour to trace their analogies to other animals.

(30.) Under the name of GASTEROPODA, we retain the greater number of Cuvier's divisions*; but the most typical consists of the univalve or spiral *Testacea*, whose body is protected and generally covered† by a calcareous shell: the head, although not assuming a very decided shape, is always present, and is, in almost all instances, at once distinguished by having two or more tentacula, assuming the appearance of the antennæ and the palpi of insects. All the true *Gasteropoda* possess the rudiments of eyes; in the generality, these organs appear in the form of black specks, either at the tips of the longest pair of tentacula, as in the common snail, or at their base. We thus find that the true *Gasteropoda* possess four primary characters,—the power of crawling upon their belly, the possession of a head and eyes, and, finally, the protection of a shell. Those which are most remote from the point of perfection, and which form the links of connection to other classes (as the *Tectibranchia* on one side, and the *Nudibranchia* on the other), have some one, or, perhaps, two, of these characters either lost, or but very imperfectly developed; these, in short, are the aberrant groups, and must never be looked to for the right understanding of the class to which they belong. The slug, for instance, has no shell, or merely the rudiments of one; yet it crawls upon its belly, it is furnished with a distinct head and even jaws, it has four tentacula, and a pair of rudi-

* As the *Heteropoda*, *Cyclobranchia*, *Scutibranchia*, and *Pulmonaria*.
† Except in *Limax*, &c.

mentary eyes; it presents us, in fact, with all the characters of a testaceous gastropod, except one,—that of being covered by a shell. In the *Tectibranchia,* again, we have a group still more remote from the typical structure; for many of these have the mere rudiments of a shell covering a small part of their body, and they swim as much as they crawl. Yet their evident connection to the *Volutidæ* (by means of the *Cypræidæ*) on one side, and to the chitons on the other, points them out as truly belonging to this order.

(31.) The DITHYRA of Aristotle, or bivalve shells, form the next, or sub-typical division. This comprises animals destitute of an apparent head, but still inclosed in a shell, and still moving on the belly. There is not, however, in this latter part, any flattened disk; and the shell, instead of being spiral, is generally composed of two pieces, or valves, joined together by a horny ligament. The *Dithyra,* moreover, are further distinguished by having neither tentacula, nor the least vestige of eyes. We meet with some, indeed, as the *Chelisomæ,* which have no external shelly covering; and others, where the bivalve shell is inclosed in a tube, as the family of *Tubulibranchia,* — thus assuming the disguise of a univalve. But these remarkable deviations are few, and point out, as we have just mentioned, the extreme limits of the tribe.

(32.) The NUDIBRANCHIA, or tritons (part of the naked *Gasteropoda* of M. Cuvier), form the third of our principal divisions, and are all no less strongly characterised. Destitute of any covering, and presenting a marked peculiarity in their external branchia, their appearance is so very different, that every unprejudiced observer cannot but wonder they should, up to this day, have been mixed up with the true gastropod shell-fish. These animals, in fact, are entirely flattened, naked, soft, and generally ornamented with beautiful colours; they move about by means of their foot, or concave underside of their belly, in the depths of the ocean; on the sides, and often on the upper part of their

bodies, they are provided with processes like filaments; and there are generally two very short tentacula, at the termination of which are two black dots, representing the eyes; in this respect they certainly show a relation to the *Gasteropoda*, but then their respiratory organs are totally different. The *Nudibranchia*, in short, as their name implies, have these organs arranged on the upper part of their body, in the form of a rosette, so as exactly to resemble a bunch of vine leaves, whose stalks form a common centre. One, out of the three great characters of the typical *Testacea*, is yet retained, — for the animal crawls upon its belly; but has lost the other two, — since they have neither a distinct head nor shell. The tritons and dories have the additional power of swimming and crawling on the surface of the sea, with their foot uppermost: in the former case, they are propelled both by their branchia and the thin sides of their body, which act in the manner of fins.

(*33.*) Our next group is composed of those simply constructed *Testacea*, which represent the *Acrita* in this class, and which have hitherto been arranged among that heterogeneous assemblage of animals, named *Intestina* by Cuvier. Having now arrived at the most remote limits of the *Testacea*, we find, in the order before us, nothing more than faint indications, or, in other words, the elements, of that organisation which belongs to the typical tribes. The flattened disk-like form, indeed, of the dories and the tritons is fully preserved in the *Planariæ*, and even in some of the *Fasciolæ*; but the branchia, hitherto so variable, now become less and less apparent, and finally disappear. Some of these animals inhabit the water, but others are internal or external parasites; and this change of habit takes place in groups so intimately connected in all other respects, that we become convinced of the propriety of retaining them in one and the same assemblage. Hence, without venturing to determine the precise limits of the animals which really belong to this class, we feel no hesitation in considering a large portion of Cuvier's PARENCHYMATA,

or intestinal worms, as truly belonging to this class. Our reasons for this will be again adverted to. At present, it will be sufficient to state, that these animals are totally distinct from the true *Vermes*, where the body is composed of articulations more or less developed, and which consequently form the corresponding group in the annulose circle. Nearly all of these imperfect and obscurely known animals, however, partake of the general character of the *Testacea*, in crawling or adhering by their belly, beneath which, — as in the *Fasciolæ*, — there are cup-shaped disks, or suckers. Analogous, in every respect, to these, are the arms of the next tribe.

(*34.*) In this manner, then, are we conducted to the fifth and last tribe of the testaceous *Mollusca*, — namely, the CEPHALOPODA, or cuttlefish. But this is done by the intervention of a group of animals, almost as simple in their organisation as the intestinal tribe last mentioned. Some of the *Pteropoda*, in fact, like the *Parenchymata*, are without head, branchia, eyes, or any external members; even the fin, so universal among the *Firolæ*, is wanting in such genera as *Timorenia* and *Monophora*: but these, or any of the *Heteropoda*, are not the animals to which we must look for the typical characters of the group before us. The types of the *Cephalopoda*, in fact, are the most highly organised, and, therefore, the most perfect, of all the *Testacea*. The appearance of these animals is strange and grotesque in the extreme. Their body is soft and pulpy, having the limbs arranged in a circle round the mouth; these limbs perform all the offices of feet, arms, and tentacula, and, in many genera, they are used also as fins. The head, which, in all the other *Testacea*, is either wanting or but slightly developed, is here large and conspicuous; while the eyes are so clear and distinct, that they resemble those of a vertebrated animal; the mouth, from the arrangement of the limbs, or, as we shall term them, the arms, is consequently in the centre, like that

of a radiated animal; and the sides of the body are either slightly dilated into a distinct fin-shaped membrane, or are so thin that it can be used for the same purpose. In size, the cuttlefish are by far the largest of all the testaceous *Mollusca;* they are, indeed, the giants of invertebrated animals; for, if the accounts of the old Indian voyagers are true, there are some of such enormous dimensions, that they seize upon the divers, entangle them in the folds of their serpent-like arms, and finally devour them. These stories are, no doubt, exaggerated; but we have, ourselves, seen many of such a size, caught on the shores of Sicily, that two would be a good load, — their arms being as thick as those of a man. Most of these animals now in existence are naked; but in the former æras of the world, there appears, unquestionably, to have been a most numerous and gigantic race, which had a part of their body protected by a spiral shell, rolled in the form of a disk. Ancient revolutions of our globe, however, have swept away nearly the whole of these testaceous monsters, leaving in the *Nautilus* almost the only genus hitherto found in a recent state. It is among the existing genera that we find a horny or calcareous plate, which supports the body, and is altogether internal. This, as before remarked, is the first indication of the vertebrated structure among molluscous animals; and hence, nearly all zoologists place these animals immediately in junction with the *Vertebrata:* or what is the same thing, consider them the last in the series of the *Mollusca.* It thus appears, on a general view of the whole of the testaceous *Mollusca,* that they may be thus concisely described: — The typical and sub-typical divisions crawl, and are covered with calcareous shells; of which the first is univalve, and generally spiral, while that of the other is bivalve and simple. The aberrant group, on the contrary, have no calcareous covering, but are externally naked, and they have the faculty of swimming added to that of crawling. Thus, we cannot but admire the simplicity and beauty of the

distinctions which nature has thus stamped upon the primary groups, infinitely diversified as they are in all other respects.

(*35.*) Our next object is, to show upon what grounds our conviction rests, that these orders form a circular group, more or less perfect. It is hardly necessary to apprise the zoologist, that in this class of animals, above all others, the effects of those revolutions in our globe, which have nearly exterminated so many races of animals, are most apparent. It appears, at first, difficult to say whether this destruction has been most extensive among those whose hard vestiges yet remain in a fossil state, or among such as, being entirely soft, have altogether disappeared, and "left not a wreck behind." Our own opinion, however, is decidedly in favour of the latter supposition. Four fifths of the testaceous *Cephalopoda* have certainly disappeared; yet their shelly portions, abounding in incalculable quantities in all the older formations, are yet sufficient, with the aid of the few species now existing, to give us some general idea of the chain of continuity: but, among the *Nudibranchia* and the *Branchiopoda*, whole families seem to have disappeared: such of the latter, indeed, as possessed a hard covering may be judged of by their shells; but in what way their union was effected with the existing races of *Dithyra* it is altogether impossible to judge. The *Nudibranchia*, again, are allowed by all naturalists to constitute a distinct tribe; and yet it does not contain more individuals, or a greater diversity of structure, than may be met with in any one of the numerous families of the gastropod *Testacea*. Now, it must be remembered that these are all soft, and often subgelatinous, animals, without any hard or durable parts whatsoever; so that all that have only existed in former periods of our globe, have been exterminated both in life and substance, no indication whatever remaining that they ever had existence. Upon what ground, then, it may be asked, do we take for granted that they *have ever* been among the things that were? and what

reason is there to suppose any one has been abstracted from the living races? To this we would simply reply, that such a conclusion is borne out by every principle of analogical reasoning. Throughout the whole of the vertebrated classes, it is solely in groups where congenial forms have been found in a fossil state that we find the gradations in the living series broken and interrupted. Very few such interruptions, for instance, occur in the class of birds, and they are so slight as hardly to merit such a term: this fact, in our estimation, at once accounts for the extreme rarity of the remains of birds in a fossil state; scarcely any having been exterminated. The living series is, consequently, almost perfect. Not so, however, among the reptiles. In that class there is an entire order (the *Elaniosaures*) which has been so absolutely exterminated that not a living example remains; hence, but for the fossil bones of the *Ichthyosaurus*, *Plesiosaurus*, &c., there would not merely be a wide and violent disruption of the reptile series, but an absolute impossibility of forming even a rational conjecture as to its course; at least, in that dissevered portion which these extinct reptiles actually fill up. But we will bring this theory more home to our present purpose. There is no circular series of living *Testacea*, wherein is found every modification of form necessary for unquestionable connection, more perfect than that of the predaceous shell-fish (*Gasteropoda Zoophaga*): hence the extinct fossil species are not only rare, but they nearly all belong to genera now living, and therefore termed *recent*. Any one family in this group, in short, contains more species and genera than are now known in the entire tribe of *Nudibranchia*, or in the family of *Branchiopoda*. What, then, are the legitimate deductions from these facts? We must take our choice of these two:—Either we are to suppose that Nature at first made these latter groups as imperfect as they now are, while all others, abundant in recent species and forms, are perfect; or that she has removed from the creation most of those links which would fill up the

intervals between the existing races, and which, were they now living, would render all her groups equally perfect. All analogy, drawn from theory or from facts, compels us to embrace this latter conclusion. PERFECTION in all His works is one of the attributes of the Creator; it is therefore clear that nothing imperfect could have entered into the plan of the creation.

(36.) An attentive consideration of the vertebrated classes of animals, both collectively and separately, will convince the philosophic inquirer, that in every instance nature begins, as it were, from a small rudimentary group, — a *point*, so to speak, in existence, — which seems to contain such animals as have the very least affinity to those which, standing at the head, exhibit the typical structure; they possess only the rudiments of the perfection to which they gradually, but ultimately, lead; and their structure is often so exceedingly simple, that, in such as may be termed the germ, even these rudiments are scarcely perceptible. One such, or at most two, are all we can expect to find. Hence it follows, that such imperfectly formed beings, although found in every large division of animals, must necessarily possess a strong resemblance to each other; although, in reality, they belong to classes widely distinct, when we trace them up to their full developement. This theory, although in some respects not new, — for it has been tacitly or indirectly admitted in a general way, — has never received that attention it deserves. It has consequently resulted, that nearly all those authors who overlook the important differences between *analogy* and *affinity*, have naturally supposed these rudimentary animals, as they may be called, were closely connected to each other *by affinity*, and have accordingly classed them as such. This seems to be the true cause why we have such a heterogeneous assemblage of animals under Cuvier's class of *Intestina*, and even in those of MacLeay's *Acrita* and *Vermes*. They agree, indeed, in one respect, — that is, of being the most simple of all others in structure; but this is altogether more a negative

than a positive character, and altogether fails of that accuracy, to be desired. Besides, it is quite evident, that, if the several threads of affinity—collected together in the above-mentioned groups — had been followed up, each would have been found leading to totally different divisions of the animal kingdom. The *Acrita*, in fact, as at present constructed, is such an ill-defined group, that some writers think they are bound to bring within its limits the Medusas, and many of the most perfect radiated animals; so that, if this is allowable, there is no reason whatever for excluding the annulose *Vermes*, the cephalopodous *Foraminata*, and the molluscous *Parenchymata*. It may be thought somewhat premature to state these objections, seeing that we have not yet attempted to substitute any other arrangement of the *Acrita* * for that which we hold to be a false one, although proposed by the very founder of the class. But we are all aware that the perception of an error, and the power of rectifying it, are not inseparable. Our researches may have proceeded quite far enough to satisfy us on the former, and yet may not have extended, or have been sufficiently matured, to accomplish the latter. It is precisely in this predicament that we now stand. Our researches in the true *Acrita*, the *Radiata*, and the *Annulosa*, — have advanced sufficiently far to convince us of the fundamental truth of what we have just advanced. The subject, however, is of such vast importance to the first principles of natural arrangement, that we may well devote to it a few additional remarks.

(37.) If we look to the vertebrated circle of animals, we find that many of the amphibians are the most simply constructed of all the *Vertebrata*; the *Amphiuma* are worm-like salamanders, having the body excessively

* We trust this investigation may be taken up by the only naturalist of this country who has devoted himself to the study of the soft *Mollusca*, and from whose talents, experience, and zeal, we may expect so much — Dr. Johnson. It is a serious loss and inconvenience to science, that the numerous and truly valuable memoirs of this accomplished malacologist are now scattered in periodicals and magazines, almost hid in a mass of temporary and trivial articles.

lengthened, and the legs and feet so small as to be rudimentary; while the *Cœcilia* have neither feet nor branchia, and sometimes are without eyes. This group, therefore, among the *Vertebrata*, is precisely the sort of point or nucleus from which diverge two distinct series of animals: the one leads to the serpents, or reptiles; the other branches out, in an opposite direction, to the fishes; but both these ultimately meet in the ostrich, which exhibits a union of the bird and the quadruped. Each of the five divisions of the vertebrated circle afford parallel instances; so that we invariably find the most aberrant group is always that which is the least organised; just as is the class *Acrita* in the whole animal kingdom. The annulose *Vermes*, as the tape-worms, and other intestinal creatures still more simple, forming the *Tœnioides* of Cuvier, are, in the annulose circle, precisely what the amphibians become in the *Vertebrata*. They exhibit the first simple outlines of that structure which terminates in the painted butterfly and the sagacious bee; and, when nature has reached these points of perfection, she returns, by slow degrees, through the *Annelides*, or red-blooded worms, to the same point, although by a different route. Such, also, will be found her course in the testaceous class. The *Parenchymata*, or parasitic *Mollusca*, may be considered the first indistinct and incipient developement of the *Testacea*, — the point from which nature diverges towards the phytophagous gastropods on one side, and to the carnivorous gastropods on the other, until both these series meet together, and form a perfect circle in the family of *Turbidæ*. It will subsequently appear that this remarkable principle of variation is not merely confined to the first great circle formed by the *Testacea*; it is abundantly evident in its primary divisions — nay, in some instances, even in its families. Among the *Cephalopoda* it is particularly strong. All writers who have mentioned the *Foraminifera*, so admirably and beautifully investigated by D'Orbigny, hesitate not to place these microscopic atoms in that order, although it

contains the most perfect *Mollusca* in existence. And yet the organisation of these beings is so very simple, that, if no regard be paid to the difference of analogy and affinity, they might be placed next to the animalculæ in the class *Acrita*. The chitons among our *Gasteropoda*, and the genus *Chelisoma* in the circle of the *Dithyra*, are further instances: both are the most simple and slightly organised of their separate groups; and both, in this respect, as well as in the shape of their bodies, are prototypes of the *Planaridæ* and *Fasciolæ*, among the parasitic *Testacea*. But the universally confessed affinities of the naked slugs to the testaceous snails brings this theory home to the personal cognisance of every naturalist. Some of these creatures are so small, gelatinous, and so little organised, that, but for their indisputable and immediate affinity with the beautiful land shells of the *Helix* race, no one would think of placing them in the same order, much less in the same family; and yet every zoologist sees that such is their natural situation. Hence these naked slugs become nothing more than prototypes of the *Planariæ* and *Fasciolæ;* related, indeed, to them by *analogy*, but without any connection whatever in regard to *affinity*. The extraordinary genus *Herpa*, one of the splendid discoveries of Guilding (which will be subsequently noticed), carries this analogical resemblance to the highest pitch; so that, but for the discriminating acumen of that profound observer, we should have been tempted, without seeing the animal, to consider it was an actual type of *Planaria*, in the disguise, only, of a *Limax*. On these, and numerous other similar facts resulting from the analysis of this class, we hesitate not to place a portion of Cuvier's intestinal worms as the most aberrant order of the testaceous *Mollusca*. We wish to follow nature, and nature only; perfectly satisfied, from past experience, that, however various and conflicting may be the comments of her interpreters, she has pursued but one course, and but one plan, in her system of animal variation.

(38.) We may now commence a rapid survey of the course by which the class before us resolves itself into one great circle, the further details of which will be noticed under the several chapters devoted to the chief divisions. We have already expressed our conviction that the germs of the *Testacea* exist among the various discordant animals comprising Cuvier's *Parenchymata,* but it is by no means clear which is the precise point where the very first indication of this structure is seen; this cannot be cleared up until the *Acrita* and the *Radiata,* not to mention the annulose *Vermes,* have been sufficiently analysed. Without speculating, therefore, on the probability or possibility of such genera as *Echinorynchus* and *Herula* being the rudimentary type, we may safely point to the *Tremadotes* of Rudolphi, and the whole of the second family of Cuvier's *Parenchymata,* as containing the vermiform or most aberrant types of the class before us. These, in fact, are nothing more, in one sense, than naked gasteropod *Mollusca,* crawling upon their bellies, or adhering by means of cup-shaped suckers, which are analogous to, and perform the same office as, the single disk of the more perfect testaceous gastropods. Some of these, like the *Fasciolæ* of Linnæus, are feeders on the internal parts of animals, and adhere, by means of these suckers, to the viscera of quadrupeds, birds, and fish; others, as *Cyclocotyles* of Otto, are external parasites; while the true *Planaridæ* are entirely free, and swim about in the water. Now, it is from these animals that nature throws out, as it were, two lateral branches. One of these, emanating from the *Planaridæ,* conducts us, in the most beautiful and graduated manner, to the *Nudibranchia;* the other, departing from the *Fasciolæ,* leads us, by means of such genera as *Menostoma* of Blainville, and *Hectocotyles* of Cuvier, to the no less vermiform animals among the *Firolæ* and other finless *Heteropoda.* This latter branch, however, we shall leave after this indication, and pursue the former. Commencing, then, with the *Planaridæ,* we see a

family as much diversified as any of the naked *Testacea*, but which, at present, remains almost as a genus. In it are found representations of nearly all the onisciform *Mollusca*, as *Sigaretus, Chelisoma, Chelinotus, Chiton*, and numerous others: the interesting genus *Tristoma* of Cuvier, contains the first rudiments of branchia,—for such do we consider that "ramified circular vessel in the parenchyma of the body," the nature of which, as that learned anatomist conceives, "it is difficult to determine."* This, together with the many beautiful and interesting forms discovered and figured by Rüppell, establishes the union of the *Planaridæ* and the *Doridæ* — in other words, the two orders of *Parenchymata* and *Nudibranchia* — in the most perfect manner. We pass, then, from these latter, to the *Branchiopoda*, the first tribe in the order of bivalves. From this point our course is plain: *Anomia* connects them with the *Ostræa* and other *Dithyra* without siphons; while these latter are connected to the more typical bivalves, where these organs are fully developed, by means of *Chama* and *Hippopus*. We quit the perfect bivalves for such as are tubular, and hence almost univalve shells, through the *Myadæ* and *Solenidæ*, and thus reach the *Teredinæ*. By this latter family, the path is smoothed to the terminal series of the *Dithyra*, — namely, the *Tubulibranchia* of Cuvier,—where we have the singular union of a gastropod mollusk inhabiting a tubular shell. The two typical orders being thus united, we enter, at once, among the spiral or testaceous *Gasteropoda*,—that group, in short, which stands at the head of the entire class. Beginning with the *Scutibranchia* or *Patellides*, as the least organised of these univalve animals, we see a gradual developement of the spire take place in the *Haliotidæ, Trochidæ*, and *Helicidæ;* until, in the *Turbidæ*, we have a union of the phytophagous and the zoophagous gastropods. The old genera of *Melania* in one, and *Cerithium* in the other, effects this union, and conducts us at once to the *Strombidæ, Muricidæ*, and, finally, to

* Griff. Cuv. xii. 473.

the *Volutidæ*. The transition from these to the *Cyprœidæ* is no less clear than that from the *Cyprœidæ* to the *Bullæ*, —the latter being the most perfect of the *Tectibranchia*. In some of these half naked gastropods, the foot-like disk of the belly is reduced to very small dimensions, while the two lobes of the mantle become so dilated that they are used as fins. In this manner does nature leave the GASTEROPODA, and unites them to the swimming order of CEPHALOPODA,—the first tribe of which is the *Pteropoda*. The straight cylindrical case of some of these singular animals, few in number, but highly interesting, prepares us for that extinct tribe of cuttle-fish of which the fossil *Belemnites*, in all probability, formed the type: from these to the spiral *Cephalopoda*, the passage is so easy, that it can be traced by the shells alone; and then, with the assistance of *Argonauta* and *Carinaria*, we at once reach the *Heteropoda*. The affinity between some of these simply constructed animals and the aberrant *Parenchymata* has already been intimated. Thus we find that the two lateral series which branch off from the *Planaridæ* meet together in the *Turbidæ*, and complete the circle of the whole class.

(39.) In thus tracing the course of the circle of the TESTACEA, the zoologist, versed in the circular theory, will perceive we have taken no notice of the most aberrant groups in each order, — and this, because it would have incumbered, without necessity, the simple exposition of the union of the orders themselves. He will also be aware that it is by these particular groups that each order forms a circle of itself. This important property will, of course, be adverted to when we come to treat of each order separately. In the mean time, we shall now compare the orders of the *Testacea* with such other groups of the animal kingdom as appear calculated to render their analogies more comprehensible to the ordinary reader. Our first comparison will consequently be with the vertebrated animals.

Analogies of the TESTACEA *to the* VERTEBRATA.

Orders of the *Testacea*.	Circle of the *Vertebrata*.
GASTEROPODA.	QUADRUPEDS.
DITHYRA.	BIRDS.
NUDIBRANCHIA.	REPTILES.
PARENCHYMATA.	AMPHIBIANS.
CEPHALOPODA.	FISHES.

(40.) The reader will bear in mind that, hitherto, we have spoken of relations of *affinity;* but our present business is with *analogies,* or mutual representations. Setting aside, therefore, all we have already advanced, we accordingly find that the best modern zoologists place the *Dithyra,* or bivalve shell-fish, close to the *Gasteropoda,* or univalves, upon the same principle as the birds, in the other column, follow the quadrupeds. This arrangement, at the very first, seems to carry with it an appearance of being natural, because we thus find that both the *Dithyra* and the *Aves* are the sub-typical divisions of their own circles. But this parallelism, although highly satisfactory, is not of itself sufficient; we must look further, and inquire whether these groups actually agree in any particular circumstance of structure, common to both. Now, every one knows that, among the many things in which quadrupeds differ from birds, their mode of feeding is altogether dissimilar. Quadrupeds are provided with jaws bearing teeth, with which the food is masticated before it enters the stomach: birds, on the contrary, have the jaws dilated into a snout-shaped bill, and teeth are altogether wanting. The rapacious birds (*Raptores*), indeed, which typify the quadrupeds, may be said, in some degree, to masticate their food; but by all others it is sucked into the mouth, the effects of mastication being supplied by the stomach. If we inquire into the modes in which the typical *Gasteropoda* and the *Dithyra* take their food, we find that it is precisely conformable to the above variation. The most typical of the spiral shell-fish (*Gasteropoda*), like quadrupeds, are provided with fleshy lips and corneous jaws, varied, as M. Cuvier truly observes, into numerous modifications; while in many genera (on the same authority), the inside of the cheeks

are provided with reflected teeth, to aid deglutition. On turning to the *Dithyra*, however, we find a totally different structure: the mouth has neither lips, jaws, nor teeth, but is "a simple aperture" entering into the stomach; the food, in short, is sucked in, and is swallowed entire, as it is by birds: so that, strange as it may appear, the two most perfect groups of the testaceous *Mollusca* exhibit, generally speaking, the same mode of feeding as the two most perfect groups of vertebrated animals. It seems hardly necessary to strengthen analogies so beautiful; yet we cannot omit, in this place, that there are not wanting indications, even in the structure of the bivalve shell-fish, to remind us of the peculiar, character of birds: in these latter, the sides of the body are enveloped by two broad and expansive wings; in like manner is the body of an acephalous bivalve enveloped on its sides by the ample folds of its cloak or mantle. Yet neither of these appendages occur among the typical quadrupeds and the typical gastropods.* But it is time to pass on to the *Nudibranchia* and the reptiles. Do these represent each other? and in what manner? We will set aside that forbidding appearance which these reptile-looking *Mollusca* possess; and which indicates, at first sight, some analogy to the true reptiles, because this is a mere matter of opinion: not so, however, is the circumstance that both these classes crawl upon their belly, and are destitute of any limbs. The tritons, in fact, have no real feet; and the serpents, standing at the head of the *Reptilia*, are eminently distinguished in the very same way. The analogies of the *Parenchymata*, in general, have been sufficiently explained; it is, therefore, only necessary to observe in this place, that the *Amphibia* are the most imperfect of the vertebrated animals, just as the *Parenchymata* are the most simply constructed, and the furthest removed from the typical *Testacea*. Their short, thick, and broad form reminds us again of the oniscifform type of annulose animals. We have now only to

* Except in such as are aberrant in their own circles, as the *Volutidæ*, &c.

compare the two last groups in our table, — namely, the *Cephalopoda* and the true fishes. These agree in containing the largest individuals of their respective circles, — except, indeed, the fish-quadrupeds, or whales. Both swim by means of their fins, which in both groups represent the arms and feet of other animals: the eyes of both are almost perfectly the same: the old naturalists, indeed, who were more led by general appearance than by anatomical peculiarities, considered the cuttlefish and *Loligo* as true fishes. It may, therefore, safely be said, that, if we are to decide which division of the *Testacea* bears the greatest resemblance to fishes, — whether as regarding outward form or internal organisation, — no one would hesitate to name the *Cephalopoda* as that group.

(41.) In further confirmation of this arrangement, we will take a slight glance at the classes of annulose animals (which are to form the next volume of our series), and compare them with those of the *Testacea*. It is scarcely necessary to dwell upon the two typical groups of each, — the *Gasteropoda* and the *Ptilota*, which stand as the pre-eminent; and the *Aptera* and *Dithyra*, as the *sub-typical* classes: when, however, we proceed to the aberrant groups, we find the analogies, as in all other instances, much stronger. How beautiful, for instance, do the *Annelides*, or red-blooded worms, put on the very aspect and form of the *Nudibranchia*; a naturalist, looking to the outward appearance of these creatures, — their naked body, often covered with tufts of plumed or ramose appendages, assuming sometimes the likeness of horns, filaments, or tentacula, — would even entertain a suspicion that they really belonged to the same class of animals. No wonder, therefore, that the older naturalists, and even Linnæus, mixed them together; since the circumstance of one having red, and the other white, blood, was not, in those days, considered a matter of much importance. Now, this analogy, which is perhaps one of the most striking in the whole of the animal creation, is highly important

when viewed in reference to any doubts which may hang over this group, from its isolated situation on one side of its own circle. The strong analogy between the *Parenchymata* and the annulose *Vermes* has induced all writers to blend them together, even up to this day; the one being the most imperfect of all the *Testacea*, as the other is of the *Annulosa*. Passing on to the relationship between the cuttlefish (*Cephalopoda*) and the barnacles (*Cirripeda*), we are struck with a resemblance much stronger than would be supposed to result from a mere relation of analogy. In both these tribes, the mouth is surrounded by long slender arms, employed to catch their prey; both contain animals whose softer parts are protected by shells. Nevertheless the *Cirripedes* have no more to do with *Mollusca*, than the latter have with those crabs, which, like the genus *Cyclops*, are naturally enveloped in bivalve shells. To the *Radiata*, again, the analogy of these tribes is no less apparent; for, as both have the organs of motion arranged around, or rather radiating from, their mouth, which thus becomes the common centre, they have, to all outward appearance, the essential characters of radiated mollusks.

(42.) Assembling all the groups thus brought into comparison in the following table, we shall see, at one glance, the mutual relations they present in their component parts.

Analogies of the TESTACEOUS MOLLUSCA *to the* ANNULOSA.

Tribes of *Testacea*.	*Analogical Characters.*	Classes of the *Annulosa*.
GASTEROPODA.	Typical, the most highly organised; head distinct, with long antennæ or tentacula.	PTILOTA.
DITHYRA.	Head indistinct, confounded with the thorax, or altogether wanting; no antennæ or tentacula.	APTERA.
NUDIBRANCHIA.	Disk of the belly flattened, and often performing the office of a foot.	ANNELIDES.
PARENCHYMATA.	The most simple in their organisation, naked, and crawl upon their belly; no perceptible branchia.	VERMES.
CEPHALOPODA.	Mouth surrounded by long tentacula, or arms; soft parts of the body generally protected by a shell.	CIRRIPEDA.

So singularly do the *Aptera* represent the *Dithyra* by the head (as in spiders and scorpions) being confounded with the trunk, that they might even, without any violation of propriety, be termed acephalous insects. But we presume enough has now been said on this set of analogies, to satisfy the unprejudiced reader. And having now sufficiently dwelt upon our arrangement of the *Testacea* as a class, we may at once proceed to the details of the tribes in which the whole are here arranged.

CHAP. III.

ON THE ORDER OF GASTEROPODA, ITS PRIMARY DIVISIONS, AND THE CHARACTERS AND ANALOGIES OF THE MURICIDÆ AND THE TURBINELLIDÆ.

(43.) THE gastropod shell-fish, as we have already shown in the preceding pages, stand at the head of the testaceous *Mollusca*, — a station which both Cuvier and Lamarck have also assigned to them. This has now been confirmed by the theoretical and analogical tests with which our last chapter was concluded. But as our arrangement of these animals will be in many respects very different from that of preceding writers, it will be proper, before submitting its details to the reader, that we should take a short review of the group as it at present stands in existing systems.

(44.) On referring to the definitions given in the *Règne Animal* of the order *Gasteropoda**, and to the animals composing it, we find it embraces more than nine tenths of the whole of the *Mollusca* inhabiting univalve shells, and by far the greater part of such as are naked. The inevitable consequence of thus including a multitude of groups, differing from each other in

* Griffith's Cuvier, xii. 21.

almost every thing, has been this,—that the reader is at a loss to know by what other principle they are united, even according to the system of the learned author. Some crawl on their belly, others do not; some have shells, others none; many have a distinct head, but many have not; the eyes are present, or they are wanting: all the organs, in short, of respiration, deglutition, and reproduction, are admitted to vary; and this, in such an extraordinary manner, and in species so obviously allied to each other, that they have no claim to a primary consideration. True it is, that all these animals possess an aortic heart; but this, properly speaking, is more the universal character of the testaceous *Mollusca* as a class, than one by which such an immense number of animals, totally different in all other respects, can be distinguished. The order, as it now stands, may be said to embrace the whole of the *Mollusca*, except the *Dithyra*, or bivalves, and the *Cephalopoda*, or cuttlefish. "There is, no doubt, some great error," observes Mr. MacLeay, "yet undetected in the principles upon which we are accustomed to arrange the *Mollusca*, and that we shall never arrive at the truth, by looking, like M. de Blainville, solely to the position and structure of the organs of respiration; or, like M. Cuvier, to the method of reproduction, as when he unites the *Cyclobranches* to the *Acephala* or *Dithyra*.

(45.) Rejecting, therefore, all those animals from the true gastropods, which have neither a distinct head, as the *Tubulibranchia*, or whose branchia are naked, as in *Doris*, we shall retain an assemblage of mollusks, nearly all of which are furnished with univalve shells*; and whose head, distinguished from their body, is provided with tentacula and eyes; the flattened part of the belly serving them as a foot. Thus restricted, we shall find that nearly all the remaining divisions of M. Cuvier, under certain modifications, indicate so many natural groups. It is clear, however, that when M. Cuvier

* Except in *Chiton*, where the valves are separate and dorsal only, and some of the *Tectibranchia*.

places such genera as *Planorbis* and *Ampullaria* in two different orders, merely on account of a difference in their organs of respiration, he falls into as great an error as that he has elsewhere committed in uniting the *Cyclobranchia* to his *Acephala*. The order *Pulmonaria*, therefore, must be clearly abolished. This, indeed, has been already done by Lamarck, whose authority on all questions of natural affinity must, in general, be regarded as superior to that of Cuvier.

(46.) With the foregoing restrictions, the primary divisions of the order before us will be found to consist of the five following tribes:—1. The ZOOPHAGA of Lamarck, or the carnivorous shell-fish (corresponding to the *Pectinibranchia* Cuv.); 2. The PHYTOPHAGA of the same author, which live chiefly on vegetables, as the snails and slugs; 3. The SCUTIBRANCHIA *Cuv.*, or limpets; 4. The CYCLOBRANCHIA *Cuv.*, or chitons; and, 5. The TECTIBRANCHIA *Cuv.*, or bullas, whose univalve shells, where they exist, are all hid in the flesh of the animal, while their mantle is dilated into two fin-like lobes, with which they can swim. We shall now state a few general particulars of these tribes, and then proceed to determine their analogies.

(47.) The ZOOPHAGA are the most pre-eminently typical of the whole of the testaceous *Mollusca*; and this holds good, whether we regard the organisation of the animal, or the symmetry and beauty of their external shell, with which, in every instance, they are provided. They have only two tentacula; and the eyes, which are always conspicuous, are sometimes (as in the *Strombidæ*) highly developed. The edge of the mantle is almost always provided with a siphon, or tube for respiration, and by which the animal can breathe without protruding its head and foot from the aperture of its shell: this siphon is protected by a corresponding canal, either long or short, at the base of its habitation; and its presence, in all these *Mollusca*, constitutes one of their most essential characters. The mouth, also, is very remarkable, — resembling more or less, as Cuvier well

observes, "an elongated proboscis. Their tongue," he continues, "is armed with little hooks, which, by slow and repeated rubbings, act upon the hardest bodies." It is by this process that they perforate, with the smoothness and precision of an auger, the shells of other animals, which they then destroy and suck the juices of. The sexes are always separate; and the aperture of the shell, in most instances, is closed by an operculum. The various modern genera formed out of the Linnæan *Murex, Buccinum, Conus, Voluta,* &c., are included in this tribe, the shells of which are always spiral, and furnished with a notch or emargination at the base.

(48.) The PHYTOPHAGA, as the name implies, are feeders upon plants; for although several, like the slugs, will devour animal substances, they more habitually live upon vegetables. They are, besides, eminently distinguished from the carnivorous race by two characters: their mouth does not form a proboscis; and the aperture of their shell is entire,—in other words, without the notch or canal for the passage of the siphon (when it exists), so universal in the last group. In all but one or two genera, as the slugs and the marine *Onchidæ,* they are more or less covered with shells, which, in however small a degree, are always spiral. By far the greater part of them have the sexes separate; but in regard to all the other organs connected with respiration, they may be said to vary in every possible way,—a clear proof that such variations, in groups naturally and closely allied, cannot be taken in an arbitrary sense. Many of these animals have their branchia as in the *Zoophaga;* some few, as *Cyclostoma* and *Helicina,* even according to M. Cuvier's admission (who places them, nevertheless, with his *Pectinibranchia*), "have instead of gills, a vascular network covering the top of a cavity that is otherwise similar; and they respire, like the *Limax,* the natural air." The whole of the terrestrial slugs and snails, again, breathe through an open perforation under the edge of the reflected mantle, which

they can dilate or contract at pleasure: hence they have no gills, "but merely a network of pulmonary vessels, which spread over the parietes and the roof of their respiratory cavity." The tentacula, in such as inhabit fresh water, are generally only two; but in the land and amphibious groups, as *Helix*, *Ampullaria*, *Planorbis*, &c., they are four. Their food, notwithstanding all these variations, is always essentially vegetable. Their mouth is uniformly the same, and their shell is always spiral; this latter circumstance, it should be remembered, carries with it an important character in the form of their body, which is of much consequence, and separates them from the next tribe. The whole of the land shells, as well as the marine families of *Neritinæ*, *Turbidæ*, *Trochidæ*, &c., are comprised in this division; the *Haliotidæ*, or ear-shells, being the connecting link to the next.

(49.) The SCUTIBRANCHIA have the same system of respiration, according to Cuvier, as his *Pectinibranchia;* but they differ not only in their mode of reproduction, but most remarkably in the form of their body. They are all attached to their shelly covering by an amazing strong muscle, which fills the centre, and gives them such an adhesive power, that they affix themselves immoveably to other substances, from which they can only be separated by the sudden insertion of some sharp instrument. They are, in fact, affixed *Testacea;* for although the animals can move about, they cannot live but upon a substance where they can instantaneously fix themselves. In their internal structure, we find the heart, according to Cuvier, "traversed by the rectum, and receiving the blood from two auricles, as is the case in the greater number of bivalves." * The form of the shell is no less peculiar; its general shape is that of a low, broad-based pyramid, or, if viewed inside, of a very wide but shallow funnel. The common limpet, in short, appears to us the most typical of the whole;

* It is by this group, in fact, as will subsequently be shown, that we consider the *Gasteropoda* and the *Dithyra* are united.

for although this genus has been excluded by some writers, and separated from *Fissurella*, &c., in a distinct tribe, yet this is evidently doing a violation to nature. None of the genera in our present group possess spiral shells; for although *Haliotis* is obviously intermediate between the *Phytophaga* and the *Scutibranchia*, its preponderating character, both as regards the animal and the shell, appears to us in favour of its being placed as the last of the turbinated families, rather than as the first of the present group. Thus restricted, the *Scutibranchia* will contain *Patella*, *Siphonaria*, *Fissurella*, *Emarginula*, *Parmophorus*, *Capulis*, &c., together with the singular genus *Hipponyx*, of which we shall have occasion to speak hereafter. *Magilis* and *Siliquaria* evidently disturb this series, yet open a direct path to the *Dithyra*, or bivalves.

(50.) The Cyclobranchia, according to Cuvier, "have the branchia resembling small lamellæ, or little pyramids, forming a cordon more or less complete under the borders of the mantle, very nearly the same as the *Inferobranchia*," from which, however, he separates them on account of their different system of reproduction: "the heart," he continues, "does not embrace the rectum, but its situation varies; the stomach is membranaceous, and the intestines very long." The only genera placed by Cuvier in this group, are *Patella* and *Chiton*. The first, however, is so evidently connected to the *Scutibranchia* in all other points of organisation, setting aside the shell, that we have no hesitation in adopting the theory of Lamarck, who unites the genera *Phyllidia* and *Diphyllidia* to *Chiton*, particularly as this arrangement at once opens a direct passage to the *Tectibranchia*. The shells of the chitons, which thus become the types of the *Cyclobranchia*, are boat-shaped and multivalve, the valves being disposed transversely upon the back of the animal, and folding over each other like a coat of mail.

(51.) The Tectibranchia, to which we are conducted by Lamarck, form a most natural group. It is peculiarly

interesting, because it contains those diverging genera which connect it not only with the chitons, but with the *Gasteropoda* on one side, and the *Cephalopoda*, on the other. They may be described as thick, fleshy, soft mollusks, generally possessing a distinct head furnished with a pair of ear-shaped tentacula, and with the mantle usually dilated into two lobes resembling fins: the branchia are folliculated on the right side or on the back, and are generally covered by a small bulla-shaped shell concealed in the folds of the body. They have the power both of crawling by means of a narrow disk on their belly, and of swimming by their fins. Many of the species are very large, and when taken out of the water they appear like great oval masses of flesh. They are the only swimming gastropods possessed of a univalve shell, and are connected to the *Cephalopoda* by the singular genus *Gasteropteron* Meck., which thus brings us at once to the *Pteropoda;* while the connection of the *Bullæ* to the *Cypræidæ* is obvious to every one.

(52.) The union of the *Phytophaga* and the *Zoophaga*, or the typical divisions, is so perfect, that the only apparent difficulty seems to be where one terminates and the other begins: thus, if we look to the possession of a siphon as a primary distinction of the *Zoophaga*, we find this organ fully developed in the sub-aquatic genus *Ampullaria*, which is nevertheless so closely united in its other characters to the *Phytophaga*, that we cannot separate it from its obvious allies: the mouth of the shell, in fact, is as entire, or rather as destitute of any notch or canal, as that of the garden snail; while *Planaxis* and *Melanopsis*, both of which are most intimately related to *Melania*, have a deeply notched aperture. If we look to the relations afforded by the animals themselves, the same interchange of characters takes place. As these two groups follow each other in affinity, we may pass on to the *Helicidæ*, or land snails, and the marine *Trochidæ*, until we reach the *Scutibranchia* by means of such genera as *Trochella*, which

unites the essential character of a turbinated *Trochus* with those of the patelliform *Calyptræa, Capulis*, &c. By following this clue, we arrive at once among the limpets, while the *Naticidæ* branch off and unite again with the *Turbidæ*. It is quite indifferent to our present purpose, whether *Haliotis* is retained in the *Scutibranchia*, or within the confines of the *Phytophaga;* but we may here anticipate our subsequent analysis, by stating that it truly belongs to the latter, where it forms a particular family, representing the limpets. Having arrived, therefore, among these latter shells, the most simple of all the univalve *Testacea*, nature returns to the carnivorous gastropods through the *Cyclobranchia* and the *Tectibranchia;* so that the junction of the latter with the *Cyprœidæ*, as before remarked, completes as perfect a circle as any, perhaps, in the entire animal kingdom. From this disposition of the groups results the following table of analogies: —

Analogies of the Tribes of GASTEROPODA *to the Orders of the* TESTACEA.

Tribes of *Gasteropoda.*	*Analogical Characters.*	Orders of the *Testacea.*
ZOOPHAGA.	Pre-eminently typical; mantle formed into one or two long tubular siphons.	GASTEROPODA.
PHYTOPHAGA.	Siphons entirely wanting.	DITHYRA.*
SCUTIBRANCHIA.	Animal oval, greatly depressed; the branchia, in the typical divisions fringed, and placed on the back.	NUDIBRANCHIA.
CYCLOBRANCHIA.	Tentacula none; body broad, oval, onisciform.	PARENCHYMATA.
TECTIBRANCHIA.	Shell, when present, protecting only a part of the body, concealed; mantle dilated into fin-like lobes.	CEPHALOPODA.

It is not a little extraordinary that these two series of animals, which in their external aspect are so very dissimilar, should yet present such strong analogies to each other; the *Scutibranchia*, in fact, may be called *Nudibranchia* provided with shells; and, in the same way,

* The sub-typical group, of course, is the one here compared, and there the animals have no siphon.

the *Planaridæ* among the *Parenchymata* are naked chitons (*Cyclobranchia*). The *Cephalopoda,* in like manner, are as perfectly represented by the swimming tribe of the *Tectibranchia;* and like them, also, have their shell internal. Adverting, again, to the two first analogies, we find the primary types, the *Zoophaga* and the *Dithyra,* furnished with long siphons, or tubes, which are totally wanting in the secondary types. To this table, however, we may hereafter return; and, in the mean time, we shall enter at once on the most typical families of the entire class.

(*53.*) The tribe of the ZOOPHAGA, or rapacious shell-fish, is distinguished by a tubular or proboscis-like mouth, a respiratory siphon, and two tentacula, upon the sides or near the base of which are the eyes. In some few, as in the cowries (*Cypræa*), the mantle is external, and almost envelopes the shell; and this, we suspect, is likewise the case in some of the *Volutidæ,* or volutes; but in general it is internal, and of ordinary dimensions. Nearly all are provided with a horny operculum for closing the aperture of their shell; but in the *Cones* and *Columbellinæ* this is reduced to a mere vestige; while in the *Cypræidæ,* and such as have the lobes of the mantle very much developed, it is unnecessary, and therefore does not exist. All these variations, however, in the operculum are slight and trivial, in comparison to those exhibited in the form of the animal and the construction of the shell. Here the greatest variety, and the most regular constancy in the variation of natural groups, is everywhere discernible. Hence it is, that while our primary attention must be directed to the variation of the animal, we must still have a sufficient regard to its testaceous covering. It is the abuse, and not the judicious use, of a regard to the shell, which is to be condemned. A system built only on the variation of the animal, would be as useless and insufficient for all practical or philosophic purposes, as another would be detrimental to sound principles of classification, if it was framed entirely on the form of the

shell. The first would include, like the old systems, all manner of spiral shells, under the generic name of *Buccinum;* while the other would place *Parmophorus, Fissurella,* and *Umbrella* in the same group as the limpet, merely because they had similar shaped shells. While, therefore, we make this and all our other chief divisions to repose on a primary consideration of the soft parts of the body, we regard the construction of the shell as much a part and parcel of the animal itself, as are the wings of an insect or the hard covering of the chelonian reptiles. The shell of testaceous animals, in fact, is precisely analogous to the covering of the tortoises, and are to be considered in the same light, — that is, furnishing a secondary, although a very important, set of characters for the determination of the minor groups. It is not a little remarkable that, as the tribe before us is the most completely organised, and therefore the most typical of the whole of the *Testacea*, so do we find their testaceous coverings are the most complicated, and by far the most beautiful of all the spiral univalves. The gradual transitions of form which they present, even when there is little or no variation in the animal, or, at least, none that has yet been detected, is a clear proof, if any other was wanting, that all our secondary characters taken from the shell, are those which nature herself has employed to designate the subordinate groups. The definitions, therefore, of the families in which we shall now arrange this tribe, will be mainly taken from the shell, at the same time introducing all such information regarding the soft parts of the inhabitant as appear of primary consequence.

(54.) The five leading divisions of the *Zoophaga* may be thus named and defined: — 1. The MURICIDÆ, or murexes, having the respiratory siphon in general very much developed, and its corresponding canal at the base of the shell always straight. 2. The TURBINELLIDÆ, or turnip-shells, where the base of the shell is straight and lengthened, and the pillar strongly plaited. In both these, the mantle of the animal is never dilated, but is

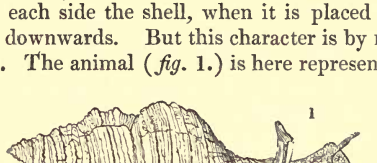
of ordinary dimensions, and drawn back into the shell with the animal. 3. The VOLUTIDÆ, or volutes, having the mantle much developed in the typical species: the column of the shell is always marked by regular and well-defined plaits, nearly the same as in the last; but the base of the aperture is obtuse, truncate, and notched. 4. The CYPRÆIDÆ, or cowries, whose shells are without any spire; the last whorl enveloping all the others, as in the bullas. 5. The STROMBIDÆ, or wing-shells; the only division where the outer side or lip of the aperture is considerably dilated. The two first of these are the typical and sub-typical groups; the three latter forming the aberrant circle. The whole are marine.

(55.) The MURICIDÆ, or whelks, are resolvable again into the following sub-families, each of which contains genera and sub-genera: 1. The *Muricinæ*, or murexes*; 2. The *Cassinæ*, or helmets; 3. The *Buccininæ*, or whelks; 4. The *Purpurinæ*, or purpuras; and, 5. The *Nassinæ*. These we shall now enter upon in the above order of arrangement.

(56.) The MURICINÆ is a very diversified and (from the little yet known of the animals) a very difficult group to arrange. Generally speaking, they are strong shells, of a rough exterior, without any plaits or teeth either upon the pillar or outer lip: the different periods of their growth, or rather of their enlargement by the animal, are marked by thickened transverse ribs called varices, which are differently disposed in the genera: the canal is generally short, or of moderate length, but always present, and usually a little bent on one side. The aperture is oval; and the spire nearly as long as the body-whorl. They chiefly abound in the shallow waters of temperate seas; and are either covered with an epidermis of their own, or by extraneous marine substances. The typical genus is *Murex*, where we find some of the most beautifully coloured shells, and certainly the most elaborate in structure, among the whole of the spiral univalves.

* Sometimes called rock-shells, from the roughness and irregularity of their surface.

This and *Ranella* appear to be the two typical genera; but of the three aberrant divisions, *Triton* is the only one that has been yet named or defined. The foliated varices of *Ranella*, and the sharp tubercles on the whole shell, joined to the additional canal at the upper part of the aperture, indicate that this group is naturally connected to *Murex;* but the species are very few, and present no very marked deviation from the typical form. In *Triton*, however, the case is far otherwise. The species are not only more numerous, but exhibit in their structure so many different modifications, that there is no one generic character to which there are not exceptions in some of the species. The most usual is that of having but few varices, and these placed alternately; whereas in *Ranella* they are so united as to form a continuous ridge on each side the shell, when it is placed with the aperture downwards. But this character is by no means constant. The animal (*fig.* 1.) is here represented from



an unpublished drawing by Guilding; the tentacula are short, and the eyes at their base. This remarkable diversity in the genus *Triton* is easily accounted for, on the ground that this group contains representations of all others in the family, besides aberrant forms leading to the more proximate genera. The two other aberrant types, which we consider as completing the circle of the *Muricinæ*, we name *Vitulina* and *Muricidea*. The first is advancing towards *Murex*, and is represented by the *Murex Vitulinus* of authors, and is distinguished by having the varices nearly obsolete, and the pillar smooth, broad, and flattened, like a purpura.

The type of *Muricidea*, is the harp-like *Murex Magellanicus*.* Where, as in very many other of the small murexes, the progressive growth of the shell is marked by longitudinal ridges, either foliated or spined, sometimes as close together, and nearly as regular, as those upon the harp-shells. The outer lip is quite smooth, and the inner lip thin: there is no internal groove; and the basal canal is almost always closed over, so as to form an internal tube, open only at the two ends. The connection of this group of *Murices* to the true genus *Murex* is so close, that they have never, until now, been separated; so that, being connected to *Triton* by means of *Vitulina*, also a Lamarckian murex, we find the whole forming a circular group of themselves.

(57.) In the CASSINÆ, or helmet-shells, the first character which strikes us is their large and often gigantic size: the spire is remarkably short; and the base, instead of being prolonged, as in the *Muricinæ*, is either truncated so as merely to present a wide notch, or is very short, and turned back on the body-whorl. These are the typical characters of the sub-family, but much remains to designate the genera. Our attention has been more especially called to this group, not merely from the size and beauty of the shells, but from the great reluctance some conchologists have manifested to adopt the genus *Cypræcassis*, proposed by Mr. Stuchbury, whose valuable Essay upon the growth of corals has rendered his name familiar to naturalists. That *Cypræcassis* possessed a decided relation, either by affinity or analogy, to *Cypræa*, we had long been persuaded. But we freely confess, that previous to, and even for some time after, its being proposed as a genus, we looked upon it only as a subordinate type of *Cassis*. Anxious, nevertheless, to arrive at some definite conclusion on this point, we were induced to re-examine the whole of the Lamarckian genus *Cassis;* the result of which has convinced us that our first impression was erroneous, and that *Cypræcassis* is as truly a natural genus as any in

* Ency. Méthod. pl. 414. fig. 4. *a*, *b*.

the whole circle of the *Testacea*. It will be needless in this place to enter into the definitions of this and the other four genera, since they will be found in our systematic arrangement; but they may shortly be characterised in the following manner: — In *Cassidea* and *Dolium*, the aperture of the shell is always wide, rarely with distinct varices, and the outer lip never dilated into a marginal rim over the body-whorl; but in the first, the inner lip is reflected, thickly marginated, and generally toothed, while in the last it is always thin: these will be found, upon analysis, to be the two typical genera. In the harps (*Harpa*), which obviously follow the tuns (*Dolium*), the whole shell is marked by varices, which assume the form of ribs. Now, the ample information given by M. Quoy on the animal of this genus, not only fixes its station in the present circle, but demonstrates it to be a representation of the volutes, with which that admirable malacologist compares it. This important point being determined upon such high authority and unpremeditated testimony, we arrive, by induction, at the station of the two remaining types. *Cyprœcassis*, consequently, intervenes between *Harpa* and *Cassis*; and this latter fills up the interval between *Cyprœcassis* and *Cassidea*. Thus, the *Cassinœ*, like the *Muricinœ*, form a circle of affinity among themselves, and present one of the most beautiful set of analogies to be found among the families of *Testacea*.

Analogies of the CASSINÆ *to the Families of* GASTEROPODA.

Genera of the CASSINÆ.	*Analogies.*	Families of GASTEROPODA.
CASSIDEA.	Typical; basal channel never straight.	MURICIDÆ.
DOLIUM.	Sub-typical.	TURBINELLIDÆ.
HARPA.	Foot of the animal enormously large; mantle dilated; tentacula short.	VOLUTIDÆ.
CYPRÆCASSIS.	Aperture of the shell linear; both lips regularly toothed, the inner spreading, but never prominent; aperture with a channel at each extremity.	CYPRÆIDÆ.
CASSIS.	Outer lip gibbous or angulated above, considerably dilated on its margin; eyes of the animal highly developed.	STROMBIDÆ.

As no very tangible analogies exist between the shells of the two first groups in each column, we may fairly presume that they exist only in these hitherto not well defined animals, particularly as it is only by this means that the resemblance of *Harpa* to the Melons, or typical volutes, has been established; and yet, when we look at a harp-shell, we cannot assimilate it to any other than a coronated volute. The analogy between *Cyprœcassis* and the cowries is too strong to be insisted upon; and in this view it is quite unimportant whether the former has or has not an operculum, for the relation, in either case, is clearly one of analogy, and not of affinity: we are disposed to consider the common *C. testiculus* as the type, simply because it puts on more the aspect of a cowry than any other species we have seen; it is less nodulous, and its slender longitudinal ribs accord more with those of *Oniscia* and other cypræform types. *Cassis*, itself, is indubitably a prototype not only of the *Strombidæ*, but of the *Nassinæ*, to which it at once leads through the intervention of *Cassidaria*.

(58.) It is not a little remarkable that while the genera of the *Cassinæ* represent the families of the carnivorous gastropods, those of the pre-eminently typical *Muricinæ* have a more especial reference to the sub-families, as will be seen by the following exposition: —

Analogies of the MURICINÆ *to the Sub-families.*

Genera of MURICINÆ.	*Analogies.*	Sub-families of MURICIDÆ.
Murex.	Typical of their respective groups.	*Cassinæ.*
Ranella.	Sub-typical.	*Muricinæ.*
Triton.	Spire generally longer than the aperture; base short, nearly truncate, straight.	*Buccininæ.*
Vitulina.	Inner lip broad, smooth, and flattened; basal channel narrow.	*Purpurinæ.*
Muricidea.	Base of the shell slightly produced.	*Nassinæ.*

Here, again, insufficient acquaintance with the animals very much lessens the interest of these comparisons; and yet there can be no doubt that *Murex vitulinus* of

authors is more a murex than a purpura, — that *Triton* passes into *Buccinum*, and therefore represents it, —and that, of all the carnivorous gastropods *out* of the *Cassinæ*, *Murex Magellanicus* and its allies have the greatest similarity to the harp-shells. This is all we would maintain. For the rest, there is such an extreme regularity in all the existing species of *Harpa*, that we may fairly conclude the aberrant examples have become extinct, or have possibly not been discovered. One species, however, of *Muricidea*, with the ridges of *M. Magellanica*, but with a truncated base, would connect the two groups; and when we consider that, in *Triton*, the comparative length of the channel is only used to designate the species, we may fairly conclude there is no violation of nature in supposing that *Harpa* and *Muricidea* pass into each other. As for the analogy between the latter and *Nassa*, we have at this moment a species of *Muricidea* before us, whose canal is reflected backwards precisely as in the common *N. arcularia*.

(59.) The typical distinction of the Nassæ lies in a very thick deposition of enamel which encircles the aperture, and not only spreads far beyond the inner lip, but forms a vitreous mass all over the under part of the body-whorl. The only other genus of predaceous *Testacea* having a shell thus constructed, is *Cassis*, and a few tritons, which are probably its representatives. Nevertheless, there are many *Nassæ* which have this peculiarity but slightly developed, and others in which it is not at all apparent; in all, however, there is a prominent internal ridge at the base of the pillar, and a small transverse tooth on the upper part of the inner lip. These shells are all of a small size, and abound in the shallow waters of Southern Europe and the East. Among the unpublished researches of Guilding*, is a highly finished drawing of a species from St. Vincent's (*fig.*2.), which throws an important light on the animal:

* Now in the possession of his widow.

from this, it does not appear to have a probosciform mouth; but the anterior part of the foot is prolonged into a subulate point on each side, and the hinder part terminates in two little tail-like appendages. Now this has much of the character of our genus *Leiodomus* *, figured by Quoy and Gaimard; and, although both they and their shells are too dissimilar to be placed in the same group, they may be considered analogous.

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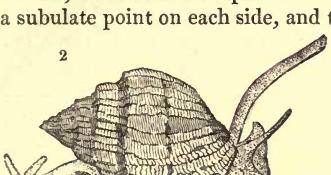


(60.) The broad, spreading, and dilated inner lip of *Cassis* prepares us at once for the sub-family of NASSINÆ, which is entered by the genus *Cassidaria* of Lamarck. These shells differ from all those we have just left, by having the basal canal considerably more lengthened, and only slightly turned backwards, without reposing on the shell itself: they are of an intermediate size between the largest *Nassæ* and the smaller helmets; and thus the gradation even of size is preserved. The typical genus *Nassa* then succeeds: the species, although all of them small, are much varied in shape, and in the degree in which the inner lip is developed; but the twisted ridge at the base of the pillar, the striated aperture, and the tuberculated tooth at the top of the aperture, are so constant, that they must remain as they now are in our systems, until their sub-genera are worked out. There is one form, however, so very remarkable, that we have placed it as the genus *Cyclonassa* *: it is the only snail-shaped flattened shell in this tribe; and the animal, when known, will no doubt be very curious. Our next genus, *Vexilla*, opens the passage to the *Purpurinæ*, which it perfectly resembles in general form, and in its broad depressed inner lip; but the outer

* Bucc. agathé *Quoy, Voy. Astrol.* pl. 31. fig. 17.
† *Cyclops* of Montford; but this is a long established genus of crabs.

one is slightly inflected, and distinctly toothed. There is still wanting another genus possessing some of the characters both of *Vexilla* and *Cassidaria:* this genus is *Oniscia* Sow., where the inner lip is still more inflected and toothed, and the spire much shorter than in *Vexilla,* but yet with something of the protruding basal channel and general aspect of *Cassidaria.* As Mr. Sowerby has judiciously alluded to this affinity, we need not defend its existence. The circle of the *Nassinæ* thus becomes closed; since we have returned to *Cassidaria,* or to that genus with which we began.

(61.) We shall now see how beautifully this natural series coincides with that of the *Cassinæ,* and rightly estimate the additional value attached to the genus *Cypræcassis,* without which an important link would be altogether wanting.

Analogies of the NASSINÆ *and the* CASSINÆ.

Genera of NASSINÆ.	*Analogical Characters.*	Genera of CASSINÆ.
Nassa.	Typical; inner lip much developed; spire not depressed; base of the pillar internally carinated; the basal canal reflected backwards.	*Cassidea.*
Cyclonassa.	Spire very short, more or less depressed; the basal canal truncated.	*Dolium.*
Vexilla.	Aperture very effuse; outer lip often crenated.	*Harpa.*
Oniscia.	Ovate; inner lip spreading, but not margined; outer lip thick, inflexed; both lips striated and toothed.	*Cypræcassis.*
Cassidaria.	Ventricose; generally tuberculated; basal canal curved backwards.	*Cassis.*

To dilate upon this table, would be almost implying that our conchological readers were purblind. And yet, for those who are not scientific, we may advert to the intimate resemblance which some species of *Nassa* bear to the small helmet-shells in *Cassidea;* so that, but for their size, a superficial tyro would mistake one for the

other. *Vexilla* represents, in outward form, and most perfectly in colour, *Harpula vexillum*, just as *Harpa* typifies the crowned volutes. *Oniscia* and *Cypræcassis* are perfect counterparts of each other; while *Cassidaria* and *Cassis* complete this system of analogies. If any doubt existed as to the absolute union of *Oniscia* and *Cassidaria* in regard to affinity, it is set aside by a remarkable shell obligingly sent me by Mrs. Stuchbury, where the characters of both are united. This is of much additional importance, because it shows that *Cassidaria* does not form one of the five types of the *Cassinæ*, but merely leads to them from the *Nassinæ*. These, therefore, are the grounds upon which we have adopted Mr. Stuchbury's genus *Cypræcassis*. And while we return his opponents our best thanks for stimulating our attention to the subject, and thus detecting a material error of our own, we sincerely trust that he himself will prosecute his researches with the same ability and with the same success; to the true advancement of our favourite science of MALACOLOGY.*

(62.) The PURPURINÆ form the next sub-family in our arrangement. They include shells whose general form closely resembles the *Buccininæ*, or whelks, but with this difference,—that the pillar, without being elevated round the margin, is very much thickened, yet always more or less flattened and depressed—not, as in the generality of shells, convex. This, in truth, is the only character seen in the shells, by which this assemblage is in any way linked together. For the rest, the spire is almost always very short; the aperture large and wide; the inner lip not otherwise developed than by a transparent polish spread over it, which is sometimes

* I cannot pass over this opportunity of publicly expressing my obligations to his worthy brother, Mr. S. Stuchbury, of Theobald's Road, one of the first commercial naturalists in London, for the free use he has always given me of any interesting shells in his collection, without the necessity of *purchasing* them; a liberality not always met with. With him, I have named a series of types of the greater part of the new genera here defined, and I feel assured he will supply them to collectors on the most fair and moderate terms.

thickened in the middle, so as to form a slight elevation; and in one genus (*Ricinula*), both lips being toothed renders the aperture very narrow: they are all heavy, thick, and rough shells, often armed with tubercles and spines, but never with varices; there is generally an internal groove at the top of the aperture. The true type of the whole sub-family, which is a representation of the *Cyclobranchia*, is *Concholepas*, — a most singular-formed shell, which was long classed as *Patella*: next to this follows *Monoceros*, having a basal spine at the aperture much developed. Following these, we place certain shells where the basal notch is so small as to be nearly obsolete. Of all the different modifications in the genus *Purpura*, as it now stands, we think these point out the third sub-genus, since they are evident representations of *Cerithum*, *Melania*, and other half-emarginate groups: the spire is very short, and the pillar curves inwards. Following these, which we distinguish by the name of *Microtoma*, come the ordinary *Purpuræ*; and these blend imperceptibly into *Ricinula*, by means of *P. columellaris*, and *Ricinula aspera* and *morus*.*

(63.) *Ricinula* is a most remarkable genus of small prickly shells, with a very short spire, and the mouth, in the typical species, so beset on both sides with tooth-like projections, that the aperture itself becomes remarkably narrow; but these teeth are only developed at the matured age of the animal, and even in some species they are very small; nevertheless the pillar is almost always flattened. The gradual developement, and sometimes the digitated outer margin, of the external lip, shows a strong analogy to the *Strombidæ*, while the toothed aperture instantly reminds us both of *Columbella* and *Cassis*: all these relations will be still more determinate, if the circle of the *Purpurinæ* is tested on the same principles as those last examined. It is this group, in fact, which unites the *Purpurinæ* with the *Nassinæ*, by means of *Vexilla*, where we see in the toothed outer

* Ency. Méth. pl. 317. fig. 4. 6. † Ibid. pl. 317. fig. 5.

lip the last indication of *Ricinula*. The connection, again, of these singular shells to *Concholepas* seems to be effected by our *Ricinula planospira*†, which has the spire nearly obsolete. This, as we believe, is the true course of the circle, the contents of which find their representatives in the sub-families. It really seems advisable that the sub-genera of *Ricinula*, *Nassa*, *Triton*, and such varied groups, should be characterised when the science is somewhat more advanced.

(64.) There is one set of analogies, however, resulting from this disposition of the *Purpurinæ*, which we cannot omit, because it illustrates that sub-family by which they are represented in the circle of the *Turbinellidæ*, — namely, the *Pyrulinæ*. This will also save much useless repetition when we come to speak of the latter group.

Analogies of the PURPURINÆ *and the* PYRULINÆ.

Genera of the PURPURINÆ. Pillar flattened.	*Analogical Characters.*	Genera of the PYRULINÆ. Pillar convex.
Concholepas.	Shell smooth; spire excessively small, scarcely projecting; aperture very effuse.	*Ficula.*
Monoceros.	Spire more lengthened, conic.	*Pyrula.*
Microtoma.	Shell smooth; spire small; aperture very effuse; the basal canal narrow and almost obsolete.	*Rapella.*
Purpura.	Shell ponderous, rough, often spired; basal canal wide, and fully developed.	*Myristica.*
Ricinula.	Pillar, or inner lip, toothed.	*Cuma.*

Considering that these sub-families belong to two superior divisions, of which each is the most aberrant type, the coincidence of each agreeing in their details, is not a little remarkable.

(65.) The BUCCININÆ, or whelks, form the fifth and last division of this family: they are known from the murexes by having no varices, and from the *Purpurinæ* by the pillar not being flattened: they are generally recognised by the abrupt termination of the base, which is deeply notched. They are nearly all smooth shells,

or at least without spines, or very prominent nodules. The typical genus is *Terebra*, — the longest spired group of all the carnivorous gastropods, but so closely resembling *Turritella*, that the difference in their apertures alone distinguishes the shells. In the genus *Buccinum*, the spire is much shorter, and the body-whorl more ventricose. These seem to be the typical groups. The three aberrant will be now described. The first, which appears to us to make the nearest approximation to the wide-mouthed genus *Microtoma*, is *Leiodomus*, founded upon two shells, the animals of which have been beautifully figured* by M. Quoy. One of these is the *Buccinum lævigatum* of authors; the other, the *B. Achatinum*.† Both these have the foot of an immense size, so that it spreads over a circumference near three times as large as the shell, and is sufficient to envelope it entirely. In other respects there are some slight points of variation between the two; but they do not strike us, at present, of sufficient moment to sanction the formation of separate genera. To these we add the *Terebra vittata* ‡, and three or four other species, apparently undescribed. The *vittata*, however, appears aberrant, and leads immediately to *Terebra*. We are disposed to consider, also, as the type of another genus (*Trochia*), the species of *Purpura* of that name, — since its characters will not agree with those of *Purpura*, while the striated inner lip leads to the conjecture that it is a prototype or *Oniscia* and similar shells. Lastly, we have, in *Tritonidea* §, a remarkably varied group of small shells, some of which resemble *Triton*, and others *Buccinum*; the base, however, is always contracted, and even slightly produced; the pillar marked at the base with elevated granulations, or short obsolete plaits; and a distinct canal at the top of the aperture. The connection of this group to *Buccinum* is very obvious, while its union to *Triton*

* Ency. Méth. pl. 400. fig. 1.
† Ibid. pl. 400. fig. 4.
‡ Ibid. pl. 402. fig. 4.
§ I have since learned that this genus is the same as *Pollia* Gray, — a name I should gladly have adopted, had it not previously been given to a genus of European *Lepidoptera*.

is even more so. *Triton clandestinum* has the obsolete plaits and the internal channel of *Tritonidea;* while its thickened outer lip and more produced channel is sufficient to give it a place within the limits of *Triton*. The circle of the *Muricidæ* is thus complete; but whether *Leiodomus* is a sub-genus of *Terebra,* or really that type which passes into *Microtoma,* is a matter of doubt; its analogy, however, to *Harpa,* as shown in the animal, is a weighty consideration, although we have no intermediate links by which it is connected to *Trochia*.

(66.) The TURBINELLIDÆ form our next great division of the predatory shell-fish. As the *Muricidæ* are chiefly distinguished by the general shortness of the testaceous canal which receives the respiratory siphon, or by its total absence; so may the great majority of the *Turbinellidæ* be known by this canal being considerably lengthened.* The animals, unfortunately, of nearly all the typical genera are as yet quite unknown†; so that we have only a few detached land-marks, as it were, to assist us in the arrangement of their shells. Looking, therefore, to such characters, we observe that the *Turbinellidæ,* as a whole, are remarkable for the length of the basal canal; and that the two typical sub-families have the pillar plaited,—a character never met with in the *Muricidæ*. The volutes, indeed, possess it; but the total absence of a canal in those shells serves at once to distinguish them. We shall now arrange the whole under the following families: — 1. TURBINELLINÆ, having a large, very heavy, and smooth shell, the canal much lengthened, and the spire generally papillary. 2. SCOLYMINÆ, equally strong and ponderous with the last, but the shell is rough, with foliated spines or tubercles, as in *Murex,* and the canal short. These two are the typical groups; the first representing the *Cassinæ,* the second the *Muricinæ* of the last family; and both are

* Except in the *Eburnidæ,* and some of the aberrant *Scolyminæ*.

† Guilding has ascertained that of *Scolymus,* and Quoy those of *Eburna* and *Strutheolaria:* the former has not a probosciform mouth, but the two latter have this structure highly developed.

furnished with distinct plaits on the pillar. 3. The EBURNINÆ, where the base of the shell is truncate and notched, the pillar smooth, and the inner lip considerably thickened and spreading. 4. The PYRULINÆ, or pear-shells, having the spire short, the pillar smooth and convex, and the canal moderate. 5. and lastly, The FUSINÆ, or spindle-shells, slender and delicate, having the canal, as well as the spire, remarkably long, and generally of nearly equal length. As it will subsequently appear that these groups are of the same rank and value as those of the *Cassinæ*, we have given them the same termination in *inæ*, although their contents are by no means so numerous as their prototypes.

(67.) The TURBINELLINÆ are remarkable in their typical genus,—which is *Turbinella*,—for the excessive heaviness and even the size of their shells, for in this latter respect they almost equal any others of the family. Their surface, although usually smooth, is generally covered with an epidermis: the outer lip is rather thin and simple, but the inner is frequently thickened and margined at its basal half: there are three or four very strong transverse plaits on the pillar, placed nearer to the top than to the bottom of the aperture; but the uppermost is always largest—not, as in the *Volutidæ*, the smallest. Like these latter shells, also, the tip of the spire is almost always papillary; but this part is small, and assumes a very different appearance to that of of the true volutes. The next genus we shall notice—(there being an *hiatus* in this part of the series, which we shall subsequently advert to)—is *Fasciolaria*, where the spire is so much lengthened, as to be longer than the canal,—thus reversing the proportion between these parts as seen in *Turbinella*. The plaits on the pillar are small, placed close to the bottom of the aperture, and generally not more than two; the last being by far the largest. Some of these large shells are smooth, but a few are corrugated or wrinkled; thus preparing us for the *Scolyminæ*, to which they directly lead. Two other genera, however, enter into this circle: one of

these we designated, on a former occasion*, as the *Pyrella spirilla:* it so completely represents *Pyrula* in this group, that no one can mistake the analogy; while it differs from the old *Turbinellæ*, by having no other indication of teeth but a sharp ridge along the bottom of the aperture. Following this, we assemble nearly all the fossil *Turbinellæ* under the name of *Clavalithes:* they form, in our estimation, one of the best defined and most natural groups in malacology; and our only surprise is, that they never should have been so defined by Lamarck. The species, we believe, are all found in the plastic clay formations. They have hitherto been confounded with *Fusus*, but they clearly hold an intermediate station between that genus, or rather subfamily, and the typical *Turbinellæ*, close to which we now arrange them. The *Clavalithes*, in short, are *Turbinellæ*, without plaits on their pillar, and with a more lengthened spire, but the tip of which is also papillary: the smoothness of the inner lip, and the fusiform shape of the shell, has probably induced authors to place them with *Fusus;* but the great size of the body-whorl, the papillary spire, and the thickness and general habit of all these shells, bring them much nearer to *Turbinella*. Several species occur among the fossils of the Paris basin; and one or two of gigantic size are found at Hordwell Cliff, in Hampshire. We have now indicated four of the types of form or genera, which compose the natural series of the TURBINELLINÆ: but there is a hiatus between *Turbinella* and *Fasciolaria;* and this cannot be filled up by any shells which, so far as we are aware, have yet been published. As this form, according to our theory, should represent *Scolymus* and *Murex*, we should expect it would have the general shape, and plaits on the pillars, of *Turbinella*, but with the rugosity and perhaps the spines of a *Scolymus* or *Murex*. Now, such a recent shell we have a distinct recollection of seeing, many years ago, in the hands of a dealer; and we

* Zool. Ill. series i.

remember, at the time, being completely puzzled as to what genus it should be placed in. This, of course, was when we were entirely ignorant of those principles of variation in the *Mollusca* here developed; but we made a memorandum of the occurrence at the time, conjecturing that it might hereafter be useful. Such we now think it, inasmuch as it realises the very form which is requisite to complete the circle we are now upon. Finally, the long spire of *Clavalithes* is continued to *Turbinella Scolymus* *, which differs only in this respect from *T. rapa*.†

(68.) The *Scolyminæ*, as already remarked, are rough, blunt-spined shells, having the aspect of many of the Linnæan murexes: but the canal, although short, is straight; the pillar is furnished with distinct plaits, generally central; while the spire is always pointed. The animal we can fortunately describe from the unpublished drawings of our late friend Guilding: the foot of *Scolymus* is a little longer than the aperture, the the breadth measuring one half the length; the operculum semicircular, and tolerably large, as in *Fasciolaria;* the peduncles of the eyes very long, the eyes themselves being placed more than half way from the base to the tip; the anterior part of the foot is truncate, with the angles rounded; the hinder part is also rounded; the mouth is not probosciform; and the respiratory siphon is rather short. We cannot make use of this information to the extent that could be wished; but it will become doubly valuable for comparison, so soon as the animals of *Turbinella* and of the neighbouring genera are made known. The first form which presents itself in this division, after leaving *Fasciolaria*, is our genus *Plicatella*,—an extensive group of small shells hitherto confounded with *Fasciolaria* and *Scolymus*. From the first, they are known by the little plaits upon the pillar being almost transverse (as in *Scolymus*), and not oblique, as in *Fasciolaria;* these plaits are likewise

* Ency. Méth. pl. 431. *bis*, fig. 2. † Ibid. fig. 1.

much less distinct, and of the same thickness, without the last being manifestly larger; they are always situated across that part of the pillar which forms the lowest part of the aperture, and not, as in *Scolymus*, higher up towards the middle; the situation of these plaits, in short, removes the genus from *Scolymus*, while their form and direction separate it from *Fasciolaria*. The variation in the shape of the shells is precisely what may be expected from this intermediate position. In such as approximate to *Fasciolaria*, the canal is nearly as long as the spire; while in those which lead to *Scolymus*, it is shorter: many of the species, again, put on the aspect of the spindle-shells (*Fusus*), and hence have been arranged among them; while others have the exterior aspect of *Murex*. They are all of a moderate or small size; and may be known from the *Muricidæ* by the distinctness of their transverse plaits, the absence of internal tubercular teeth on the inner lip, and their longer channel: they are united to the next genus by *Scolymus* (or *Plicatella*) *capitellum*,—a shell which may be placed in either group without any violation of nature: its predominant characters, however, appear to us to be those of the last, inasmuch as the three plates are nearly of equal thickness; whereas, in *Scolymus*, the lower are generally much smaller than the upper, and their situation is much higher. This last-named genus is a very striking one, and, being now disencumbered of *Plicatella*, admits of a much more precise definition than we originally gave it*: the shells are short, excessively heavy; the spire acute, and almost turbinate: the pillar short; the canal straight, and longer than the spire; while the whorls are rugged, and beset with blunt, simply folliculated, or plaited spines. All the species are from warm countries.

(69.) There is strong evidence to believe that the natural situation of *Cancellaria* is immediately after that of *Scolymus;* for, although the two genera, in their typical characters, are very different, we once possessed

* Elements of Conchology, p. 21.

certain species which exhibited so many intermediate characters, that, but for the peculiarly small and incurved channel of *Cancellaria*, we should have been at a loss where to place them: one, we more particularly remember, had an exceedingly wide umbilicus, nearly as large as the *Scolymus umbilicaris**, with a very similar shaped shell; and it is not a little remarkable that, in the figure of this very *Scolymus*, the base of the pillar, instead of being straight, as in all the other species, is represented as curved inwards, and with an exceedingly small notch, — two characters which are absolutely peculiar, in this group, to *Cancellaria*.

(70.) The fourth genus, *Rhinedomus*, is typically represented by the *Cancellaria senticosus* of Lamarck, but of which there are several species. It retains sufficient of the characters of *Cancellariæ* to show its true affinity to them, for the exterior surface is longitudinally ribbed, and rough with little points, and there are two distinct folds, or rather one deep groove, at the base of the pillar: but in all essential respects the true characters of *Rhinedomus* are remarkably different: the basal canal is fully developed, being deeply notched; and, what is very unusual, there is a distinct, though not a very deep, sinus close to the base of the outer lip. The animal, made known to us by the valuable researches of MM. Quoy and Gaimard, is most remarkable; but, until we are acquainted with that of *Cancellaria*, it furnishes no comparison with them. The other species of *Rhinedomus* have the spire less elongated, and thus open a passage to our new genus *Polytropa*, examples of which will be found in two well-known British shells, the *Purpura lapillus* and *imbricatus* of Lamarck: this genus agrees, indeed, with *Purpura*, in common with many other of its prototypes, in having the inner lip flattened; but the base of the shell, instead of being truncate, forms a short straight channel; the spire is always as long (generally much longer) as

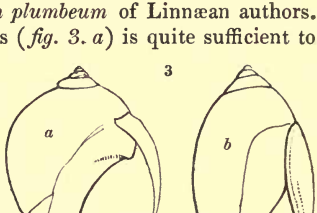
* Ency. Méthod. pl. 431. *bis*, fig. 1.

the aperture; there is also no internal canal; the inner lip sometimes has a row of tubercles. The most typical species, however, is the *Polytropa crispata.** As we recede from this genus, and approach to *Plicatella*, we find the spire increasing in length; the numerous crisp undulations give place to small nodules and little tubercles at the base of the inner lip, so that the two genera became united: the circle of the *Scolyminæ* is closed; and this, without the deficiency of a single link in the chain of connection which binds all the five genera together.

(71.) The next sub-family, *Eburninæ*, is one of very great interest, since it brings together certain genera whose station has hitherto perplexed us all. Fortunately, however, Mr. Gray has characterized the remarkable little genus *Cyllene;* and the possession of other species, joined with those of *Rhinedomus*, before alluded to, have prevented us falling into some errors: the discovery of the basal sinus, also, on the outer lip of *Rhinedomus*, at once opens a passage to *Cyllene*, which still retains a costated and somewhat cancellated exterior, with the basal sinus of the last genus. It deserves especial notice, that the species described by Mr. Gray has a distinct channel round the suture, but the other we possess has not. Now, this variation is precisely what is met with in the genus *Eburna*, the types of which are channeled, the others not. The slight striæ at the base of the pillar in *Cyllene*, are explained by its analogy to *Oliva*, just as its obsolete notch typifies its reference to *Strombus*. Other species will no doubt soon come to light; so that, with these facts before us, we have no hesitation in placing *Eburna* as the next type. Between this last, and *Struthiolaria*, there exists the most intimate relationship in regard to their animals; both have a comparatively small foot, but a proboscidiform mouth of excessive length, particularly that of *Struthiolaria*, which, when fully protruded †, is more

* Chemnetz, 187. fig. 1802, 1803. Ency. Méth. pl. 419. fig. 2.
† See the animal of *Struth. crenata*, Voy. d'Astrolobe, pl. 31. figs. 8, 9.

than equal to the entire length of the shell, while the operculum is only rudimentary. A singular undescribed shell, just communicated to us by Mr. Stuchbury, is evidently intermediate between the shape of the shells of *Eburna* and *Struthiolaria*; so that this part of our series is definite. We must now return to *Cyllene*, for the purpose of showing its close approximation to the fourth genus, *Pseudoliva*, the type of which is the *Buccinum plumbeum* of Linnæan authors. The very aspect of this (*fig. 3. a*) is quite sufficient to show its proximity to *Cyllene*, and its absolute connection with the *Volutidæ* by means of *Olivilla biplicata* (*b*). Last of all, as forming a passage to the *Pyrulæ*, we have *Latiaxis Mawæ** (Sw.), where the channel round the whorls is so broad that they become almost disconnected. At first sight, this shell would appear a monstrosity, did we not remember its prototype, *Scalaria pretiosa*, not to mention the tribe of *Tubulibranchia*. We consider it therefore as perfect in its kind, related to all the types we have noticed by its channeled suture, to *Eburna* by its large umbilicus, and to *Rapella* (the first genus of the *Pyrulinæ*) by something, very difficult to describe, in its general shape. The whole sub-family may therefore be defined as shells whose base is truncate, having a channel more or less developed round the whorls, an aperture contracted at its base, and generally either emarginate as in *Eburna*, or very slightly notched as in *Struthiolaria* and *Latiaxis*: the inner lip is much developed and spreading, without having a defined margin. The following table will also exhibit some of its analogies; the group, as a whole, being evidently a representation of the *Nassinæ* in the neighbouring family of the *Muricidæ*.



* Griff. Cuv. pl. 25. figs. 3, 4.

Analogies of the EBURNINÆ.

Genera of the EBURNINÆ.,	*Analogical Characters.*	Families of the *Zoophaga.*
Struthiolaria.	Shell nodulous or muricated.	MURICIDÆ.
Eburna.	Shell smooth; the inner lip much developed.	TURBINELLIDÆ.
Cyllene.	Base of the outer lip with a distinct sinus.	STROMBIDÆ.
Pseudoliva.	Oval, smooth.	CYPRÆIDÆ.
Latiaxis.	Spire excessively short and irregular; the whorls sub-coronated.	VOLUTIDÆ.

This comparison explains the relation which *Struthiolaria* has been thought to have, by some writers, to the murexes: the smoothness of all the *Eburninæ* is remarkable, and is no doubt an indication of their relation to the typical *Turbinellidæ*. The lobe of *Cyllene*, again, is borrowed, as it were, from the *Strombidæ*, in order to show the analogy of both. The excessive short spire of the two next is explained on the same ground; while the irregular spire of *Latiaxis* is to be found in no other shells of the zoophagous tribe, than those of the typical volutes or melons.

(72.) In the *Pyrulinæ*, or the fourth division of the family, we place the greatest part of those exceedingly diversified shells forming the genus *Pyrula* of modern writers. They are so designated from their generally being pear-shaped; the basal portion representing the stalk end of that fruit, and the spire and whorls the other. This comparison, indeed, is so far apt, that it gives a very good idea of the shape most prevalent among them, notwithstanding the great differences they present, in other respects, among themselves. This is one of the few natural groups in malacology, of which we shall endeavour to give as complete an analysis as a long and protracted investigation of their relations will permit. We have invariably found, that where natural assemblages such as this, in any division of the animal kingdom, contain a great number of subor-

dinate variations, such groups are the best calculated for discovering the true principles of variation. The interchange of characters between one division and another is better marked — the gradations more gentle — the links more perfect; and hence, by carefully tracing the transitions from one form to another, we have a better chance of correcting our previous errors, and of discovering the fallacy of any preconceived theory, than if the links were so wide apart as to leave the imagination to fill them up, by *supposing* that they have existed, or that they are not yet discovered. The complete analysis of any one group, where these deficiencies do not occur, is far more worthy the attention of the scientific, and even the general, reader, than numberless others whose links are incomplete.

(73.) The most striking characteristic of the shells composing this sub-family, next to their pear-shaped form, is that belonging to the inner lip and the columella, or pillar. It will be remembered, that in the *Purpurinæ*, the inner lip, properly speaking, is merely a thin glazing spread over that part of the pillar which forms the left-hand side of the aperture: in this respect they differ not from the shells now before us; but the pillar, instead of being broad, flat, and even concave, as in all the *Purpuræ*, is invariably rounded, and consequently very convex: the shape of the *Pyrulæ*, also, necessarily renders the base of the shell much narrower, and the canal much longer, than in their prototypes; although the *degree* of length of this channel, as well as that of the spire, cannot enter into the general definition, since it will be seen that these are subordinate characters. The five principal modifications of form under which we arrange all the species, are these:—1. *Pyrula*, where the shells are strong and solid; the whorls generally muricated; the spire short, yet elevated, well defined, and often slightly papillary; the inner lip entirely wanting; and the canal considerably lengthened. The *Pyrula perversa* may be taken as the type of this genus, all of which are strong, solid, and muricated spe-

cies. 2. *Ficula*, where the great elongation of the canal is still preserved, but the shell is differently formed, and its substance very thin. The body-whorl is more or less ventricose, and without any spines or protuberances; the spire also is so small and depressed, that the shell has very much the appearance of a *Bulla*, lengthened out at the base; and there is little or no indication of even the thin glazing which forms the inner lip: such, at least, are the characters of the typical species *, which are few and easily recognised. In *P. caudata* †, a new modification of form begins to be developed,—slightly, indeed, but quite sufficient to leave us in no doubt as to the characters of the next genus: this species has the general form of *Ficula*, but the spire is somewhat more elevated, and the inner lip is so much developed that it begins to have a defined margin at its lower part; the body-whorl loses nothing of its ventricose or inflated aspect; and the shell is remarkably thin and brittle. It is a fact highly interesting to our present purpose, that there is a shell in almost all respects similar to the *Ficula caudata* (of which it has been described as a *variety*), but which has a decidedly short canal. Here, then, is the point of junction so desirable to be established between *Ficula* and our new genus *Rapella*, typically represented by the *Ficus rapa* of authors.‡ The spire, although pointed, is still remarkably short, and almost turbinated; the body-whorl equally ventricose with the last, but the lower portion is no longer lengthened — it becomes very short, and, by the more sudden contraction of the aperture at the basal point, the canal becomes so very small as almost to be obsolete. From the absence of the inner lip in the last two genera, the shells have no umbilicus, but in *Rapella* both these characters are apparent; the umbilicus is usually very large, while the base of the inner lip is partially or entirely reflected over it. The substance of these shells varies according to the species, and

* *Pyrula ficus* Lam. Ency. Méth. pl. 431. fig. 1.; fig. 2. is another species.
† Ency. Méth. pl. 436. fig. 1. *c.* ‡ Ibid. pl. 434. fig. 1.

each presents a graduated link between the thin and brittle *Ficula papyracea* and the strength and solidity of the other types. The whole of the *Ficulæ* are smooth, except one species *, which has some very slight tubercles; but in *Rapella*, these tubercles, where they exist, begin to put on that foliated structure so prevalent in the next genus; and in others there are indications of longitudinal plaits upon the body whorl: the outer lip, however, is still very thin, and the whole may be described as a group of generally smooth shells: in one or two species, the inner lip is so much developed at its base, as actually to fill up and cover the umbilicus. Yet, in all the variations we have enumerated, the chief generic characters are constant, and the basal canal is always small.

(74.) We now come to the fourth type, or the genus *Myristica*,—a name we exalt from a specific to a generic signification for the shell now known as the *Pyrula myristica*, and which we shall here call *Myristica coronata*. These are the most dissimilar from the typical groups we have yet noticed: the form indeed, somewhat pear-shaped, — inasmuch as the spire is not longer than the contracted part of the aperture, from which the canal may be said to commence; but they have nothing of the lightness or the basal elongation of *Pyrula* and *Ficula*, or of the effuse aperture and contracted channel of *Rapella*. They may thus be described as very short, strong, fusiform shells; the umbilicus either entirely or partially concealed; the outer surface armed with muricated and semi-foliaceous spines, and marked with transverse striæ; the inner lip vitreous, but thin; the outer lip with an ascending channel above, and a wide and distinct one at the base. Now, between this and the last group there is a series of connecting links which unite them in the most perfect manner to each other; few of them, however, are figured in the more general conchological works. We may here remark, that the *P. hippocastanum* and *lineata*† of Lamarck are

* See Sowerby's Genera. † Ency. Méth. pl. 432. fig. 4, 5.

typical examples of *Myristica;* while the well-known *Pyrula melongina,* from having a much wider aperture, puts on something of the characters of *Rapella.* There are, in fact, many other species; but of our last genus *Cuma* there is only one that we are yet acquainted with, which can be termed truly typical: this we have named *C. sulcata* (*fig.* 4.). Its characters may be simply described as shorter, but more gradually fusiform, than the last, — the middle of the pillar being crossed by a single transverse and very prominent fold: this character is altogether without parallel in this sub-family; and distinguishes this type, at the first glance, from all the others: the form of the shell is much more slender at its two extremities than any of the *Myristicæ,* and, although much shorter, its aspect at once reminds us both of *Fusus* and of *Plicatella.* Nevertheless, although this shell, from having a distinct plait upon the pillar, seems to us the true type of the connecting genus between *Pyrula* and *Fusus;* it is quite evident that the common *Pyrula carnaria* *, and the more rare *P. canaliculata* Sw. †, so closely agree with the foregoing definition, that but for their smooth pillar, and the greater elongation of their base, they would both enter into the same genus. In one point of view, it may be said that these very characters, which preclude their admission into *Cuma,* may yet bring them within the confines of *Pyrula;* so that, being followed by such shells as *P. carica* ‡, &c., we come again to the typical genus with which we began the series; and yet, on the other hand, we may suppose these dubious species, to form the first genus of the *Fusinæ,* connecting that sub-family with the *Pyrulæ* by means of *Cuma.* In either way, however,

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* Ency. Méth. pl. 424. fig. 3. † Ibid. pl. 424. fig. 2.
‡ Ibid. pl. 433. fig. 3.

there is abundant evidence, even if these species are omitted, that the *Pyrulinæ* form a circular group, in which scarcely a link is wanting. This will be more evident upon arranging the whole of the genera in a tabular form, and placing the few species we have already named in the natural series of their succession.

Genera of the Pyrulinæ.

List of the Species, showing the progressive Change of one Genus to the other.

Pyrula	tuba. Ency. Méth. pl. 426. fig. 2. perversa. Ib. fig. 4. candelabrum. Ib. pl. 437. fig. 3.; pl. 438. fig. 3. carica. Ib. pl. 433. fig. 3. canaliculata. Ib. pl. 436. fig. 3. spirata. Ib. pl. 433. fig. 2. Burdigalensis. Sowerby's Genera, fig. 2.
Ficula	tricarinata. Ib. fig. 3. ficus. Ency. Méth. pl. 432. fig. 1. reticulata *Lam.* Ib. pl. 432. fig. 2. caudata. Ib. pl. 436.
Rapella	papyracea. Ib. pl. 436. fig. 1. abbreviata. Ib. pl. 426. fig. 2. effusa *Sw.* Ib. pl. 434. fig. 1. (*Pyrula Rapa.*) neritoïdes. Ib. pl. 435. fig. 2.
Myristica	melongina. Ib. pl. 435. fig. 3. *a.—d.* lineata. Ib. pl. 432. fig. 5. coronata *Sw.* Ib. pl. 432. fig. 3. *a*, *b*. hippocastanum. Ib. pl. 432. fig. 4.
Cuma	sulcata *Sw.*—followed by *Pyrula tuba*, &c.

(75.) The strong resemblance of the *Pyrulinæ* to the *Purpurinæ* is a constant subject of remark among conchological writers, and is so strong as to be often exceedingly perplexing. We now allude only to the latter group, as left by Lamarck; but many of these are so like our genus *Myristica*, that it is only upon close inspection their distinguishing characters are detected. Now, this strong resemblance can be accounted for in two ways: first, by supposing that the two groups represent each other *generally* in their own respective circles; and secondly, that this strong analogy actually extends to the *particular* genera of each sub-family.

The best way, therefore, of testing this theory, is to place these groups in separate columns, and to examine the result.

Analogies of the TURBINELLIDÆ *and the* CASSIDÆ.

Sub-families of *Turbinellidæ*.	*Analogical Characters.*	Sub-families of *Muricidæ*.
TURBINELLINÆ.	Shell large, ponderous, heavy, and mostly smooth.	CASSINÆ.
SCOLYMINÆ.	Shells rough, muricated, and generally spined.	MURICINÆ.
FUSININÆ.	Body of the animal, and spire of the shell, excessively long.	BUCCININÆ.
PYRULINÆ.	Spire always shorter than the aperture; the pillar straight and smooth.	PURPURINÆ.
EBURNINÆ.	Base and canal very short; inner lip generally formed by a thick enamel.	NASSINÆ.

(76.) Without enlarging upon the evident traces of a systematic series of analogies, running through the different groups here brought into juxtaposition, it is at once seen that the *Pyrulinæ* and the *Purpurinæ* actually come opposite each other: and having already shown (73.) how intimately their genera correspond, we may pass into the next division.

(77.) The FUSINÆ are our last sub-family, and are composed of those numerous shells arranged in the genus *Fusus* of Lamarck, and are the most elegant and delicate we have yet noticed. Their general form is that of a spindle, tapering very much at both extremities: hence the spire is very long; and as this contains the body of the animal, the circumstance forms a generic character, both for the mollusk and its shell. The canal is almost invariably long, and generally equals the spire, while the basal volution is typically small: the pillar is constantly destitute of any appearance either of plaits or teeth, and the tip of the spire is acute: this latter character, more especially, separates them from the *Turbinellinæ*, where there are, in the aberrant

genus *Clavalithes* Sw.*, several shells of an equally fusiform shape, but having the tip of the spire papillary. The shape of the *Fusinæ*, and the elongation of the body, render them very distinct from the *Pyrulinæ*, excepting at that point of junction where the two groups are united. Nothing satisfactory is known, so far as we can discover, of the general nature of the animals.

(78.) The *Fusinæ* being thus defined as a whole, we may now proceed to the series of the genera, and their peculiarities. — 1. In the first or typical genus *Fusus*, the spire and channel are both very much lengthened, and remarkably slender; the outer lip generally crenated,—the indentations corresponding with the internal striæ. — 2. *Chrysodomus*, distinguished from the last by the comparative shortness of the basal channel, and the ventricose or enlarged shape of the body-whorl. The beautiful orange mouthed wilk of England is a typical example; and the few others, now known, are all of a large size, and chiefly found in northern seas, where they represent the more elegant *Fusci* of tropical latitudes: the outer lip is always thin and smooth.— 3. *Leiostomus*, where the body-whorl is still larger than the last, while the spire, although remarkably short, is acutely pointed; the inner lip is highly polished, and the contracted base of the shell is equal, or rather longer than the aperture; the outer lip, like that of *Chrysodomus*, is thin and sharp, but thickened within. All the species of this form we have yet seen are fossil, of which the *Fusus bulbiformis*† is one of the best and most common types: the outside and the mouth of these shells are always smooth; hence their generic name. — 4. The next genus we have named *Strepsidura*, from the twisted shape of its tail or channel: the form of these shells is very much like the last, but the base or channel is equal with the spire, and is turned in an oblique direction; the outside

* We had originally called this genus *Clavella*; but as this name may be thought too closely resembling, in sound, those of *Clavagella* and *Clavatula* (Lamarck), we now substitute another, — more appropriate, indeed, as all the species we have yet seen are fossil.

† Ency. Méth. pl. 428. fig. 3.

also is marked by distinct longitudinal ribs, and has a coronated row of little mucronate spines, much like those of the harps: the type is the *Fusus ficulneus*, a fossil of Grignon.*—5. and lastly, we come to those large species represented by *Fusus colossus, coronatus, Morio*, &c., which we have arranged in the genus *Hemifusus;* they are, indeed, only half fusiform, as the spire is shorter than the aperture: they are also distinguished by an internal canal, and the whorls are coronated with compressed spines: it is easy to perceive, by the very aspect of these shells, that they form the passage to the *Purpuræ;* and their relation is so close, that, until we know something of these animals, we feel somewhat uncertain as to the station of such species as *carnaria* and *Cochlidium*. *Hemifusus*, thus standing between *Strepsidura* and *Chrysostomus*, completes the circle of the *Fusinæ*.

(79.) Upon taking a general view of these shells, we cannot but observe, notwithstanding all their modifications, that the predominant characters of the group, more or less, are preserved. In all of them we find shells more or less—equally or unequally—fusiform; that is, their thickest part is in the middle, and their two extremities attenuated to a point. No teeth, either marginal or internal, are ever seen on the outer lip, while the inner is invariably smooth: the spire, except in one type, is always longer than the basal canal; whereas, in the *Pyrulinæ*, the very reverse of this takes place. It has often been remarked by our leading zoologists,—and we have repeatedly illustrated the truth of the position,—that no groups, whether generic or otherwise, are so natural and so demonstrable as those which are linked to others by intervening gradations of form. This is, indeed, completely opposed to the old opinion formerly entertained, that no such divisions should be tolerated in systems, but such as were *distinctly separated* from each other; or, in other words, that, so soon as the

* The *Fusus heptagonus* (Ency. Méth. pl. 428. fig. 7.) probably belongs also to this genus,—although as an aberrant species.

links which connected two genera were discovered, the two should be thrown into one. Experience, however, setting aside all other considerations, has long ago consigned this dogma to oblivion, and has even obliged its warmest advocates to renounce it. Every day, almost, is bringing before us,—particularly in the invertebrate animals,—not only forms altogether new, but such modifications of those we already have in our collections, that in a few years we may fairly anticipate not one in ten of the testaceous genera, now apparently isolated, will remain so; the links which unite them to others will be discovered; and thus, had we continued to unite one genus to another in the fashion above adverted to, we should be now fast approaching that simplicity of nomenclature which would class all shells under one genus,—the genus TESTACEA. It is only by following out a theory of this sort, and seeing to what it would lead in a general and extended application, that we can judge of its philosophic soundness or of its practical utility.

(80.) All the types of the *Fusinæ*, as will now be shown, have their representatives in the *Pyrulinæ*.

Analogies of the FUSINÆ *and the* PYRULINÆ.

Genera of the FUSINÆ.	*Analogies.*	Genera of the PYRULINÆ.
Hemifusus.	Trapeziform, or sub-fusiform; channel short.	*Cuma.*
Fusus.	Channel remarkably long; the whorls generally angulated.	*Pyrula.*
Chrysodomus.	Channel moderate.	*Ficula.*
Leiostomus.	Spire very short; the basal whorl large and ventricose.	*Rapella.*
Strepsidura.	The base of the pillar slightly turned outward, the exterior rough and mucronate.	*Myristica.*

The first of these resemblances, or that between *Hemifusus* and *Cuma*, is obviously an affinity, since the most inexperienced student can perceive that these two groups pass into each other. The greatest elongation

of the basal channel takes place among the *Fusinæ* in *Fusus*, and the like character among the *Pyrula* in the opposite column; while in *Chrysodomus* and *Ficula* this part is but of moderate length. *Strepsidura* is the only genus in the first column, which, by its longitudinal plaits and prickly tubercles, corresponds to *Myristica*; while the inflated shape of *Leiostomus* immediately reminds us of *Rapella* — its prototype among the *Pyrulinæ*.

(81.) Before taking leave of the *Fusinæ*, it will be interesting to ascertain how far the genera put on the aspect of those composing the *Turbinellinæ*, more particularly as, the former being the last, and the latter — *Turbinellinæ* — the first with which we commenced, it follows, as a necessary consequence of the circularity of the whole family, that these two divisions join, and blend into each other. This, we think, will be very evident, upon examining the following table: —

Analogies of the TURBINELLINÆ *and the* FUSINÆ.

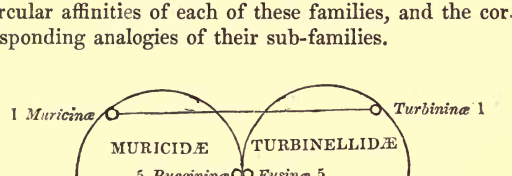
Genera of the TURBINELLÆ.	*Analogies.*	Genera of the FUSINÆ.
Turbinella Lam.	Typical of their respective groups.	*Fusus.*
?	Sub-typical.	*Chrysodomus.*
Fasciolaria Lam.	Trapeziform; the whorls turreted; canal moderate.	*Hemifusus.*
Pyrella.	Pyriform; the canal long; the base of the pillar turned inward.	*Strepsidura.*
Clavalithes.	Remarkably smooth; the spire and aperture of equal length; the pillar straight.	*Leiostomus.*

(82.) It would hardly be necessary to repeat, in this place, the fact we have so often adverted to and illustrated in former volumes, regarding the analogies of typical groups, were it not highly probable that they have not met the eye of our conchological readers. It is therefore, perhaps, necessary to apprise them, that the resemblances between the typical divisions of two groups, when thus brought into comparison, are almost always

more remote and faint than those which relate to the aberrant divisions, — and for this simple reason; — the typical groups are furthest apart from each other; while the aberrant ones, by which they are connected, are consequently nearer. In this branch of science, moreover, the difficulty of discovering the analogies of typical groups is still further increased, when, as in the present instance, we are without that precise information on the animals, which might furnish us with some analogical points of resemblance. Besides, it must always be borne in remembrance, that our arrangement is not built upon these analogical comparisons, but upon absolute or presumed *affinities*, the result of minute analysis. Whatever coincidences, therefore, arise on comparing the different groups, are more properly the *result* than the *cause* of their arrangement. Analogy is thought to be of the highest importance for the *verification* of a natural group, but it must always be subordinate to affinity. Applying these general remarks to the two typical groups which stand first upon our list, it will be remembered that one, intervening between *Turbinella* and *Fasciolaria*, has never been made known. Passing these, however, and comparing *Fasciolaria* and *Hemifusus*, we find they are almost precisely of the same shape and proportions; and that the shells can only be distinguished by one having the pillar plaited, and the other smooth. The very name of *ficulneus*, given by authors to the type of *Strepsidura*, shows its analogy to *Pyrella*, and consequently to *Pyrula*; it is, in fact, completely a pear-shaped shell. The resemblance of *Clavalithes* and *Leiostomus* is equally striking: both are remarkably smooth shells; with the channel lengthened, and the basal volution more or less enlarged; both are fossil genera of the same strata; and although *Clavalithes* in general possess very small plaits on the pillar, and a papillary spire (without which, in fact, the genus could not be clearly defined), yet there are one or two species having the pillar, as in *Leiostomus*, perfectly smooth.

If the reader turn to the figures of *Clavalithes longævus, clavellatus, scalaris, Noæ*, and *rugosus**, and to that of *Leiostomus bulbiformis* †, he will at once perceive their mutual affinity much better than from our description.

(83.) Having now supplied all the details in our power respecting the two great families of the *Zoophaga*, or predacious shell-fish,—and which, in fact, stand at the head of the entire class of TESTACEA,—we shall lay before our readers the following diagram, which will explain, more distinctly than our usual tables, the circular affinities of each of these families, and the corresponding analogies of their sub-families.



The analogies of the two typical sub-families (1. and 2.) of the circles are very remarkable. We thus find that the *Muricinæ* stand opposite to the *Turbininæ*, and the *Cassinæ* to the *Scolyminæ*. These resemblances repose on the relative developement of that portion of the shell which protects the respiratory siphon (which must of course be modified in unison with its covering or sheath): thus, in the *Muricinæ* and the *Turbininæ*, the basal canal is considerably longer than in the *Cassinæ* and the *Scolyminæ*, where, in effect, this part is either short, or absolutely wanting. Thus it is, that we may often overlook, or be ignorant of, some one character, which, when discovered, serves as a common bond of analogy between two groups, in all other respects totally different.

* Ency. Méth. pl. 425.

† Ibid. pl. 428. fig. 1. *a*, *b*.

(84.) The genus *Buccinum* and the aberrant genera of *Fusus* are so much alike, that they can only be distinguished by the latter, as *Chrysodomus,* having the basal canal slightly produced instead of truncated. These two divisions are further remarkable for containing those genera which, by the length of their spire, contain the longest-bodied *Testacea* in the whole tribe. But for its elongated canal, *Fusus colus* and its allies would become *Terebræ;* while, but for their truncated base, these latter would be placed among the *Fusinæ.* The remarkable analogies between the *Purpurinæ* and the *Pyrulinæ* (4. 4.), having already been so much enlarged upon, need not be again repeated. The only remaining comparison concerns the *Eburninæ* and the *Nassinæ,* — two groups so closely related to each other in their typical examples, that even Lamarck, mistaking analogy for affinity, actually places them following each other: both, in fact, have the base of the shell obtuse, without any elongation; the inner lip very thick, and a strong internal groove within the aperture. But it is needless to insist upon an analogy so indisputable: we may, therefore, presume, that in these two comprehensive groups we have made good all our propositions on the laws of the natural system*; and we shall now endeavour to do the same in the succeeding families of the GASTEROPODA.

* *The Geography and Classification of Animals*, Part iii. On the First Principles of natural Classification, p. 224. Vol. LXVI. of the CABINET CYCLOPÆDIA.

CHAP. IV.

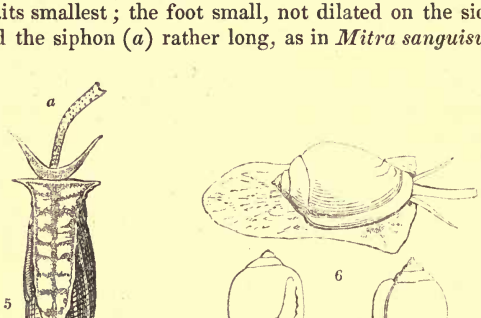
THE ZOOPHAGA, OR PREDACEOUS SHELL-FISH, CONTINUED.—THE FAMILY OF VOLUTIDÆ, OR VOLUTES.

(85.) We now come to one of the most interesting and beautiful families of the spiral *Testacea;* whether in regard to the elegance of the shells themselves, or as exhibiting a principle of variation in their structure which can hardly be excelled. Our knowledge of the animals themselves has been much increased, of late years, by the French naturalists, and by the exquisite drawings of Guilding. To generalise these discoveries, however, so as to assign some undeviating character to the whole, is almost impossible. The only peculiarity appears to be the absence of any operculum: in the majority, the eyes are sessile, placed at the base of two short tentacula, and as much developed, in the typical volutes, as they are in the *Strombidæ:* the mouth is probosciform and extensile; and the foot, in the typical group, of enormous size.

(86.) The shells, however, present us with more tangible characters. The base is never prolonged; although in some mitres (*Tiara*) it is contracted: in all others it is truncated, as in the *Buccininæ*, and deeply notched. The truncated base at once separates this family from the *Turbinellinæ*, as there is no instance of a volute with an elongated channel. The plaits upon the pillar, again, are always at the base — not in the middle only — of the aperture; although, in the aberrant groups of *Oliva, Ancillaria*, and *Marginella*, they assume peculiar modifications. The proportion of the spire to the aperture varies in almost every genus;

and is, therefore, but a subordinate character. Numerous as is this family, nearly all the species are confined to warm latitudes, particularly those of the tropics. It is hardly necessary to add, that the whole are predaceous, and consequently carnivorous.

(87.) The VOLUTIDÆ arrange themselves into five primary groups. — 1. The VOLUTINÆ, or typical volutes, having a short spire more or less papillary, and the lower plaits upon the pillar largest; the foot is excessively large, and envelopes the sides of the shell. 2. The MITRINÆ, or mitres, where the spire is always acute, generally longer than the aperture, and the lower plaits smallest; the foot small, not dilated on the sides, and the siphon (*a*) rather long, as in *Mitra sanguisuga*.



(*fig. 5.*) The first is the typical, and the second subtypical. The three aberrant sub-families are, — 3. The OLIVINÆ, or olives: cylindrical in shape; the aperture linear, and the pillar thickened and confusedly plaited. 4. ANCILLARIA: the aperture wide, and the base of the pillar alone thickened and striated. 5. The MARGINELLINÆ, or date-shells, having plaits upon the pillar, and crenated teeth on the thickened outer lip; the foot

very large, but the mantle not lobed or reflected. (*fig.* 6.)*

(88.) These primary divisions having long been admitted by all writers, we shall at once compare them with those of the predaceous *Zoophaga*.

Analogy of the VOLUTIDÆ *and the* ZOOPHAGA.

Sub-families of the *Volutidæ*.	*Analogies.*	Families of the *Zoophaga*.
VOLUTINA.	Foot of the animal excessively large; base of the shell truncate. (*Volutinæ* and *Cassinæ*.)	*Muricidæ*.
MITRINÆ.	Foot small, not so long as the shell, the base of which is contracted. (*Mitrinæ* and *Scolymus*.)	*Turbinellidæ*.
OLIVINÆ.	Spire very short; tip papillary; pillar plaited.	*Volutidæ*.
ANCILLARINÆ.	Spire nearly or quite concealed.	*Cypræidæ*.
MARGINELLINÆ.	Outer lip detached and thickened.	*Strombidæ*.

Thus, the truncated and wide-mouthed helmet-shells, among the *Muricidæ*, find their prototypes in the melon volutes; and the muricated mitres, in the sub-typical *Turbinellidæ*, with which they also agree in their fusiform shape. The *Olivinæ* correspond to the typical volutes, in having their foot excessively large. The animal of *Ancillaria* is unknown; but, from the high polish of the shells, we may suppose it is analogous to the cowries. Lastly, the *Marginellinæ* are clearly prototypes of the *Strombidæ*, as they are the only volutes which have the top of the outer lip detached from the body-whorl.

(89.) The weakest point in the foregoing table is that, perhaps, which relates to the *Ancillariæ;* but, by comparing the family with the *Cassidæ*, the station of this group will be more clearly shown.

* The annexed cut is from one of the unpublished drawings of Guilding: the shell is pure white.

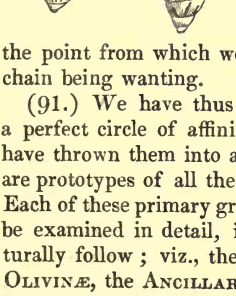
Analogies of the VOLUTIDÆ *and the* CASSIDÆ.

Sub-families of VOLUTIDÆ. *Typical Genera.*	*Analogical Characters.*	Sub-families of CASSIDÆ. *Typical Genera.*
VOLUTA.	Smooth; spire short; base truncate.	CASSIS.
MITRA.	Rough; spire longer; base attenuated.	MUREX.
OLIVA.	Foot very large; no distinct plaits on the pillar.	BUCCINUM.
ANCILLARIA.	Aperture very wide; the base of the pillar often thickened and striated.	PURPURA.
MARGINELLA.	A thick deposition surrounding the aperture of the shell.	NASSA.

This table illustrates what has been often shown among the vertebrated animals, — that, to establish the analogies of two given groups, they must often be traced through the medium of other groups: thus, the *Ancillariæ*, in one respect, are prototypes of the *Cyprææ;* and in another, by their wide aperture and striated base, are equally so to the *Purpuræ*. Again, if it was asked,— What shells among the volutes have a marked resemblance to *Concholepas* and *Monoceros?* every naturalist would point to *Ancillaria;* for all three have a very wide aperture, and a distinct prominent tooth at the base of the outer lip. This is conclusive evidence; and it therefore follows that the analogy between *Ancillaria* and *Cypræa*, however obscure in a direct way, is rendered plain by being traced through the medium of the *Purpurinæ*. The other analogies in the table are so palpable to the zoologist, that they require no illustration. Hence it follows, as a natural result of this comparison, that the *Volutidæ*, in like manner, represent all other of the circular groups in the zoophagous tribe.

(90.) Our next object is to show that the *Volutidæ*, as a whole, form a circle of affinity. It is clear that the pre-eminently typical volutes, or melon-shells, branch off into two separate series; — one leading to *Scaphella*, through *V. magnifica, fulgetrum, papillaris*, and *fusi-*

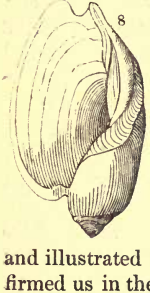
formis; the other to *Cymbiola,* or the muricated volutes. From this latter, therefore, we shall begin to trace our circle; because, even here, we have evidently a repetition of the analogy between the smooth helmets and the spined murexes. After the *Cymbiolæ,* or muricated volutes, succeed such as have the spire elongated, and the plaits upon the pillar numerous: among them is the *Voluta lyriformis;* and this brings us at once into the sub-family of the mitres: from these the passage to the olives is rendered so gradual, by *Mitrella* in one, and *Olivella* in the other, that the mere systematist will hardly admit these genera, because they blend into each other. *Hiatula* is in the same predicament: by its wide mouth, and the thickened base of its pillar, it is all but an *Ancillaria;* so that the junction is here also complete. There remains, then, only the *Marginellæ,* which are so like some of the *Ancillariæ,* that we may safely place them as next in the series. What group then succeeds? The illustrious Lamarck considered the well-known



Voluta Zebra (*fig.* 7. *a*) of our catalogues to be so like a *Marginella,* that he has actually placed it in that genus: and the affinity between this shell and *Scaphella maculata* (*b*) is immediate: we thus pass to the *S. fulgetrum,* and again reach the typical volutes. Thus, by a different route, we return to the point from which we started, without a link in the chain being wanting.

(91.) We have thus shown that the *Volutidæ* form a perfect circle of affinity; and that the divisions we have thrown them into are strictly natural, because they are prototypes of all the others in the zoophagous tribe. Each of these primary groups, or sub-families, will now be examined in detail, in the order in which they naturally follow; viz., the VOLUTINÆ, the MITRINÆ, the OLIVINÆ, the ANCILLARINÆ, and the MARGINELLINÆ.

(92.) The VOLUTINÆ, or volutes, are immediately distinguished from the mitres by being more ventricose shells, with a much shorter spire (as in *Voluta Olla, fig.* 8.), the apex or point of which is more or less thick and papillary. These characters are developed in their highest perfection in the smooth and coronated melon-shells, to which, as being the pre-eminent types of the whole family, we are compelled to retain the sub-generic name of *Voluta*. Nevertheless, these characters are greatly modified in the five leading genera, which we characterised and illustrated several years ago; and time has only confirmed us in the views we then took on the subject. We accordingly arrange the whole of the Lamarckian volutes under five leading genera. 1. *Voluta*, — having the spire excessively short, thick, and invariably smooth; the suture of the body-whorl being generally covered with a vitreous deposition or glazing, never seen in the next genus. 2. *Cymbiola*, — having the body-whorl less ventricose, and the spire longer; the apex not near so thick; while, in all those species which are coronated, the whorls are marked with tubercles. In both these groups, the plaits are almost invariably four, — the upper ones very thin and small, while the lowest is nearly double their thickness. This structure of the plaits, it may be here observed, belongs alone to these two typical genera. The third genus is *Harpula*, where the plaits upon the pillar are very numerous, — the upper ones remarkably slender, but gradually increasing in size and thickness, until the last, or the two last, which suddenly become smaller: the terminal whorls of the spire, although still papillary, are much more slender. The form of the spire, however, undergoes a change in this group, and is therefore of secondary importance. This gradual diminution of one of the typical peculiarities of the *Volutinæ* prepares us for the fourth genus, *Volutilithes*, where the apex is perfectly regular and acute.

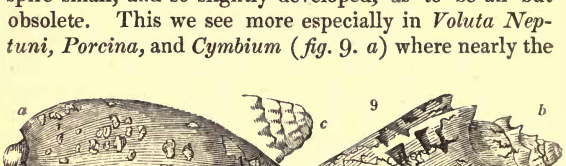


This is one of the most natural, and, at the same time, interesting groups; for no recent species has yet been found. The upper and finer plaits upon the pillar, so characteristic of *Harpula*, now disappear, and leave only one or two, or perhaps three, of the larger ones at the base: the number of these plaits, in fact, varies according to the proximity or the remoteness of the species to *Harpula*. The general shape is fusiform, the whorls being strongly coronated with spines, and often marked with transverse elevated ribs. The fifth and last genus is *Scaphella*, where the upper plaits of the pillar are as large as, or even larger than, the lower; the outer lip, also, is thickened within, and the suture of the whorls is covered by a glazing of enamel. All the species yet discovered are smooth; and from the high polish with which many are covered, there is every reason to believe the animal has a strong affinity to that of *Marginella:* this, indeed, is so obvious in the shells themselves, that Lamarck, as we before observed, has placed the *Scaphella Zebra* (*fig.* 7. *a*) in that group. The formation of the spire in general is conic, obtuse, but hardly papillary; but in certain aberrant shells, as *S. fusiformis* and *papillaris*, the apex becomes thickened, and assumes all the characters of the true volutes, and thus unite with the melons by means of *V. magnifica*.

(93.) By these typical characters, it appears to us that the natural and primary divisions of the Lamarckian volutes are regulated. In this, and all similar investigations, we have found it necessary to discard all theoretical notions as to what should be the primary types. No ordinary degree of impartiality is necessary for accomplishing this; because every naturalist, more or less, is prone to form certain preconceived notions as to what he thinks *should be* the types of any particular family; and thus, prejudiced in favour of some hypothesis, he sits down to his task, exactly in that frame of mind the most unsuited for the investigation of truth. We candidly confess that many years ago, when this

family first engaged our attention, we imbibed a notion that the formation of the spire was the chief, if not the only, character upon which they should be arranged: we soon, however, threw aside this, and fancied the same importance attached to the number of plaits: equally dissatisfied with this theory, we finally resolved to combine all these characters, without giving to any one a paramount importance: having done this, we soon perceived that these groups turned out to be representations of all those in the entire family; and this discovery prevented our falling into many errors, which would otherwise have been inevitable. We may now consider each of these genera in further detail.

(94.) The pre-eminent types of the genus *Voluta*, for reasons subsequently stated, are such shell-fish as have the spire small, and so slightly developed, as to be all but obsolete. This we see more especially in *Voluta Neptuni*, *Porcina*, and *Cymbium* (*fig.* 9. *a*) where nearly the



whole shell being enveloped, as it were, in the body-whorl, gives to it, in all but the plaited pillar, the perfect appearance of a *Bulla*. The very slight elevation of the spire is, therefore, one of the typical characters of this genus; but it is not the only one: the spiral whorls, which end in the apex, whenever they are developed, are remarkably thick, and are always perfectly smooth, although the body-whorl may be coronated; whereas in the next genus, *Cymbiola* (*C. vespertilio*, *fig.* 9. *b*), these spiral whorls are always plaited (*c*). There is a solitary

exception to this form in the true volutes, which is seen in *Voluta angulata*, where the spire is absolutely pointed: this exception, however, is a necessary one, for otherwise there would be no species which would represent *Volutilithes*. The exterior of all these shells, so far as we yet know, is covered with a thin epidermis, except, perhaps, *P. proboscidalis;* so that, notwithstanding the enormous foot of the animal, it does not appear that any part of the shell is covered by that member. The chief variations among those shells are as follows: — First, the melons, whether smooth or coronated. Secondly, the horned volutes, where the form is less ventricose, and the body-whorl armed with long spines, as in *imperialis* and *chrysostoma* *, both being connected to the coronated melons by *Broderipia* and *marmorata*. The third type is the *V. Scapha*, having the outer lip, as in the *Strombidæ*, considerably angulated and dilated. The fourth type is the *V. angulata*, whose aperture is very effuse; and the spire very short, but pointed. Lastly comes the *Voluta magnifica* and *fulgetrum* †, where we once more have the egg-shaped and inflated form of the melons, together with their very thick apex, totally different from that of the *Voluta ancilla*, &c., with which authors have hitherto placed it. The *Voluta olla* and *rubiginosa* follow this type, and blend it, in the most perfect manner, with those we first enumerated.

(95.) The passage from VOLUTA to our next genus, CYMBIOLA, is opened by the rare *V. mitis* of Lamarck; which, by its general smoothness, its thick spire, and a slight separation of the top of its outer lip from the adjoining whorl, evinces a close affinity with *V. Scapha*. The volutes now before us differ from the former, in being stronger, less ventricose, and having their spire much more lengthened: their whorls are angulated, and are mostly armed with acute spines, or

* Exotic Conchology.

† "In size and form this shell approaches nearly to *V. magnifica*." — *Tank. Cat.* p. 28.

small tubercles. Their great distinction, however, lies in the apex of their spire, which always exhibits the incipient developement, in the shape of tubercles, of those spines which may be on the body-whorl. The common *Cymbiola vespertilio*(*fig.* 9. *b*) is the type of the whole genus. From these to the next division, represented by *Cym. pacifica, gracilis,* &c., the gradation is easy and natural. Nevertheless, these Australian shells constitute a distinct division; for they are known at once by the greater prolongation of their spire, which is nearly equal to their aperture, and by the majority being only tuberculated: the apex is always obtuse and slightly papillary. Whether we should consider the *V. ancilla* (*fig.* 10.) as a distinct type of form, is uncertain, but it possesses a peculiarity of aspect, which seems to detach it from those last alluded to: the very slender shape of its apex, however, smooths the passage to the *V. braziliana* of Solander, — remarkable not only for its pointed spire, and its ventricose shape, but from possessing, like *V. angulata,* only three plaits to the pillar. It is clear that this, as well as *C. mitis,* are aberrant forms.

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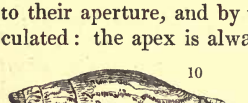


(96.) In the next genus, HARPULA, the form of the apex, which is the main character of *Voluta,* became somewhat variable in *Cymbiola;* but in this genus it is so uncertain, that it must be regarded only as of secondary importance. The numerous plaits, which extend the whole length of the pillar, are the most certain distinction of *Harpula,* which is also a more numerous genus than the last. Of the two primary types, one is seen in *H. vexillum,* which is smooth, with a papillary spire; the other, seen in *H. hebræa* (*fig.* 12. *b*, in p. 108.), is muricated, with the tip of the spire obtuse, regular, conical, and hardly enlarged. There are, however, other shells, obviously belonging to this group, which will not arrange with either of these two divisions. One,

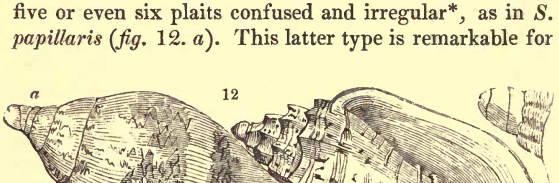
the *Harpula fulminata,* has much the shape of a *Fasciolaria,* but with the top of the outer lip slightly angulated and dilated, something in the same way as *Voluta Scapha* and *Cym. mitis.* The enlarged, knob-like form of its apex immediately reminds us of *Voluta papillaris;* while in its markings, and in the thickness of the outer lip, internally, it perfectly resembles *Scaph. undulata.* The numerous plaits, however, clearly show it is a *Harpula.* Another, our *H. lyriformis,* is the only recent volute whose spire is longer than the aperture; and a third aberrant type, the *H. bullata,* stands at the confines of this genus, and forms a passage to the next.

(97.) VOLUTILITHES, so far as is yet known, is a genus found only in a fossil state; unless, indeed, *Voluta nucleus* Lam., peculiar to the Australian seas, be considered as coming within its limits: it exhibits none of the delicate plaits on the pillar of *Harpula;* so that one half of its characters belong to that genus, and the other half to this. The typical characters of *Volutilithes* have already been detailed (92.); and as we shall particularly notice the subordinate types hereafter, we may pass onward to the next group.

(98.) The last of the primary divisions is the Australian genus SCAPHELLA; the best known type being the *Scaphella undulata* (*fig.* 11.*a*). All of these hitherto discovered, are natives of the South Pacific Ocean.

We are not aware that any of these shells have an epidermis, and their uniform smoothness leads us to conclude they are partly covered by the dilated lobes of the

mantle, as in the *Olivinæ*. This, in fact, is the only genus which is neither spined, muricated, nor tuberculated. The spire (*b*) is conic and somewhat short; the whorls of the apex are scarcely papillose; while the inner margin of the lip is considerably thickened. The plaits on the pillar, as to number, are by no means constant, even in the same species; in general, there are four, but the last is always the smallest. Sometimes, however, the pillar, at this part of the aperture, is thickened, and there are five or even six plaits confused and irregular*, as in *S. papillaris* (*fig.* 12. *a*). This latter type is remarkable for



its apex, which is suddenly enlarged into a thick nipple-like form (*b*), similar to *Harpula fulminata*, and very much like the published figure of *Voluta fulgetrum*. From this, it is clear that we have again arrived, almost unconsciously, among the aberrant forms of the melon volutes; for *fulgetrum* connects *papillaris* to *magnifica*, which, with the form of *fulgetrum*, assumes, as it were, that particularly large spire which is the chief character of the genus *Voluta*. *Scaphella papillaris*, on the other hand, is closely connected to our *S. fusiformis*, which thus unites it also to *S. undulata*.

(99.) Here we close our remarks on the affinities of these magnificent shells; but, before we enter upon the consequences of this distribution, we shall endeavour to meet some objections which may possibly be raised

* This deviation is not uncommon in *Scaphella undulata*: four is the usual number of the plaits; but sometimes, as Lamarck observes, there are two smaller and supernumerary ones. (*Lam. Syst.* vii. i. 245.) The same variation is seen in *Scaph. Junonia*.

against it. First, it may be urged, that, although the series between the smooth melons and such shells as *Voluta Scapha* is sufficiently obvious, still, that the *Voluta angulata* can never follow *Scapha*. This objection seems well grounded, and certainly deserves attention. We admit that *angulata* has a spire totally different from that structure which we maintain is typical of the group, wherein we have, nevertheless, placed it. But is there anything extraordinary in this arrangement? Does there exist, in any one class of the animal kingdom, a natural group, wherein *all* the species exhibit the *whole* of the typical characters? Every naturalist, every systematist, knows full well that no such group is to be found. It has been well said, by one of the most distinguished naturalists that this country has produced, that if a species possesses two out of the three characters of the genus in which it is placed, this is all we can expect; and the reason of this is obvious: if *all* the species possessed *all* such characters, then there would be no gradation of structure — no links in the chain of affinity — no loss of one structure — and therefore no taking up that of another. Now, all this is diametrically opposed to facts; for the whole creation is but one connected chain of such graduated progressions, — unequal, indeed, yet still graduated. The affinity of *Scapha* to *angulata* is not so intimate and direct as many others in the series; but this is nothing to the purpose, — because, as we have just said, affinities may, and do, vary in degree: the question is, whether, between these two shells, there is a sufficient resemblance to constitute any degree of affinity? When we compare the angulated apertures, the form and proportion of their plaits*, and the thick enamel spread over their spire, we see an affinity which to us is unquestionable. If *angulata*, in short, had a papillary spire, instead of a pointed one, it would be of the same type or sub-genus as *Scapha!* the pointed spire, therefore, was necessary

* Not their number, for in *angulata* there is one less.

in two respects;—first, to show that this shell was the prototype of the genus *Volutilithes;* and, secondly, to separate it from *V. Scapha.* The next type we place after *angulata* is *fulgetrum,* with which, also, comes *magnifica.* Now, the complete glazing of *angulata* (which shows the great size of the animal's mantle) is partially carried on to *fulgetrum,* which Mr. Sowerby thus describes:—"The left lobe of the mantle of the animal must have been very large, since the columella lip is extended so as to cover half of the lower volution." And that this shell exhibits a further affinity to the slender spire and angulated body-whorl of *angulata,* is evident on the same testimony.* Evidence of this sort, from an unprejudiced writer, is the very best that can be produced, since it is given without any idea of the use it may be applied to.

(100.) Our arrangement of the Lamarckian volutes, being thus founded solely upon affinity, would seem to require no additional corroboration; but beneath the surface of this beautiful chain of relationship, lies another, even more interesting, which can be only brought to light by comparing the *analogies,* which all these variations in form present among themselves. These resemblances are so remarkable, that we shall now enter upon them very fully. To do this in all cases, even were it possible, might be tedious; but in the present instance it is almost unavoidable, inasmuch as we desire that our theory on the laws of representation among the TESTACEA should stand or fall according to the success or failure which may attend their exposition in this and the two preceding families.

(101.) The principles of natural classification, so fully explained in the second volume of this series, and the innumerable proofs taken from every class of vetebrated animals that have been brought forward in the succeed-

* *V. fulgetrum* "is easily distinguished by its *acuminated* papillose spire, and by the *obtuse angle on the upper part of the last volution.*"—*Sow.*, in *Tankerville Cat.* p. 29.

ing treatises, are so well known to the majority of our readers, that it would be superfluous again to repeat them. But before we apply this theory to the group before us, a previous question must be first disposed of, — namely, upon what grounds we determine that the melon volutes are the pre-eminent types of the whole family? Now, we do not regard this as a matter of speculative opinion; it must be determined, in fact, by the analogies which the group possesses, as a whole, to other groups. The following table appears to us to decide this question:—

Analogies of the ZOOPHAGOUS *and* PHYTOPHAGOUS GASTEROPODA.

Families of the *Zoophaga.*	*Analogical Characters.*	Families of the *Phytophaga.*
MURICIDÆ.	Typical.	HELICIDÆ.
TURBINELLIDÆ.	Sub-typical.	TROCHIDÆ.
VOLUTIDÆ.	Foot of the animal excessively large; tentacula very short; eyes sessile; shell with an enormous body-whorl, and a short, nearly obsolete spire.	HALIOTIDÆ.
CYPRÆIDÆ.	Shell smooth, glossy, partly covered by the animal's mantle.	NATICIDÆ.
STROMBIDÆ.	Animal with a respiratory siphon.	TURBIDÆ.

Now, as the ear-shells are at the head of the *Haliotidæ*, it consequently follows that the melons have the same rank among the *Volutidæ*. The perfect analogy of the two families is equally remarkable, whether we look to the animals or to their shells: nay, it might be carried still further; for as there are coronated and smooth melon volutes, so are there among the ear-shells, — one division of the latter having their perforations smooth, the other having them elevated or coronated.

(102.) We may now at once compare the five genera of the *Volutinæ* with the five primary divisions of the whole family.

Analogies of the Genera of the VOLUTINÆ *to the* VOLUTIDÆ.

Genera of the VOLUTINÆ.	*Analogical Characters.*	Sub-families of the VOLUTIDÆ.
Voluta.	Shell ventricose, smooth; spire excessively short.	VOLUTINÆ.
Cymbiola.	Shell muricated; spire lengthened.	MITRINÆ.
Harpula.	The whole pillar covered with slender plaits.	OLIVINÆ.
Volutilithes.	Aperture very effuse; spire acute; base of the pillar alone plaited.	ANCELLARINÆ.
Scaphella.	Spire very short; outer lip sinuated or detached above, and thickened internally.	MARGINELLINÆ.

So completely are the five sub-families of the *Volutidæ* thus represented by all the Lamarckian volutes, that the analogical characters, or those common to both, will almost serve to distinguish each, when joined to the peculiar one which separates the two series. It will be as well, however, to apprise the conchologist, that the real type of the *Mitrinæ* is our genus *Tiara*, and not that of *Mitra*, as formerly supposed.

(103.) Having bestowed no ordinary labour in our attempt to work out the natural affinities of the *Muricidæ*, we were curious to ascertain how that arrangement would tally with the present. The result will be seen from the following table:—

Analogies of the VOLUTIDÆ *and the* MURICIDÆ.

Sub-families of the VOLUTINÆ.	*Analogical Characters.*	Sub-families of the CASSIDÆ.
Voluta.	Shell ventricose; spire remarkably short.	*Cassinæ.*
Cymbiola.	Shell muricated with spines or tubercles; spire more lengthened.	*Muricinæ.*
Harpula.	Spire often excessively lengthened.	*Buccininæ.*
Volutilithes.	Aperture very effuse; base of the pillar grooved or plaited.	*Purpurinæ.*
Scaphella.	Outer lobe of the mantle much dilated; representing *Marginella*, and consequently *Nassa*.	*Nassinæ.*

In this and the last set of analogies, we again have

an instance of that inequality in analogical relations, which, in our former volumes, we have so frequently adverted to. This inequality, strangely enough, has been somewhere urged as an objection to the theory of representation. Such reasoners seem to suppose that, unless all groups possess the same *degree* of resemblance to each other, the evidence is inconclusive. On this plan, an eagle and a lion may perhaps be admitted as analogous; but a carnivorous insect and a carnivorous beast cannot be so, because the analogy is remote or obscure. But if there are any analogical resemblances in nature, it follows, as a necessary consequence, that such resemblances are strong or faint, near or remote, according to the proximity or distance, the similarity or the dissimilarity, of the objects compared. Thus it is in the present instance: the groups being remote, their analogies are not strong; nevertheless they are substantially true, — because they are perfectly verified through the medium of other or intervening groups, which, from being more alike, render the analogies, in the same proportion, more obvious or direct.

(104.) We may now proceed a step further, and apply the same description of proof to the sub-genera, or types of form, of the typical genus *Voluta*, upon the *affinities* of which we have already said so much. We leave it to be determined by others, whether these types of form should be designated as simple divisions, or as sub-genera, and therefore to be distinguished by a patronymic name. That this will ultimately be done, we have no doubt; because they are of the same rank as the sub-genera of the other families. The shells which we view as types of form in the restricted genus *Voluta*, are as follows: — *Voluta Neptuni*, *V. imperialis*, *V. Scapha*, *V. angulata*, and *V. magnifica*. We shall now place these in one column, the two extremes of which, as we have already shown, meet, and form a circle: the next column is composed of the genera of the Lamarckian volutes, which also form another circle. Now, if the contents of one represent the contents of the other,

without any variation in the order in which each division respectively stands in regard to *affinity*, then all the verification that analogies can possibly give, will have been attained.

Analogies of the Sub-generic Types in the Genus VOLUTA.

Typical Species.	*Analogical Characters.*	Genera of the *Volutinæ* Sw. or VOLUTA *Lam.*
V. Neptuni.	Ventricose; egg-shaped; spire very short, or none.	*Voluta.*
V. imperialis.	Sub-ventricose; spire more produced; the body-whorl and spire coronated.	*Cymbiola.*
V. Scapha.	Upper angle of the outer lip advancing up the first spiral whorl.	*Harpula.*
V. angulata.	Spire with the apex acute, and not papillary.	*Volutilithes.*
V. magnifica.	Columella lip thin and much spread; shell sub-fusiform; spire short.	*Scaphella.*

Four out of the five analogies of this table are so clear and definite, that they scarcely require further illustration. We thus see how *imperialis* represents the bat volutes; *angulata*, again, puts on the pointed spire of *Volutilithes;* while *magnifica* connects *Scaphella* with the melons. The analogy between *Scapha* and *Harpula* (the heavy tuberculated species of the latter being the true types), although less apparent on a cursory view, is still very remarkable. The strong resemblance which *V. Scapha* bears to a *Strombus*, must, indeed, strike the most casual observer; but, we confess, it was some time before we discovered the singular character so prevalent in all the *Harpulæ*, or music volutes, where the outer lip is extended up the first spiral whorl, — a structure so universal among the *Strombidæ*, or wing-shells, and which is not found in any other group of the volutes. To put this analogy, however, in a clearer light, we shall now compare the types with the great circle of the *Zoophaga.*

Analogies of the Types of VOLUTA *to the* ZOOPHAGOUS *Tribe.*

Types of *Voluta.*	Genera of the VOLUTINÆ.	*Analogies.*	Families of the *Zoophaga.*
Imperialis.	*Cymbiola.*	Spines often large and acute; spire muricated.	MURICIDÆ.
Neptuni.	*Voluta.*	Spire very short, smooth; apex papillary; plaits distinct.	TURBINELLIDÆ.
Magnifica.	*Scaphella.*	Mantle very large.	VOLUTIDÆ.
Angulata.	*Volutilithes.*	The whole shell covered with enamel.	CYPRÆIDÆ.
Scapha.	*Harpula.*	Outer lip strongly angulated or elevated on the spire.	STROMBIDÆ.

This table brings out two remarkable facts. — The first relates to the analogies of *Voluta Scapha* and of *Harpula* to the *Strombidæ*—all which, by placing these three groups in separate columns, fall in precisely opposite to each other. The second relates to the analogy between the *Muricidæ* and the coronated volutes: these are all the most spiny or muricated of all univalves. The same principle of variation holds good between the smooth melons and the typical *Turbinellidæ:* both are remarkably smooth shells; both have very short papillary spires; and both have three or four well-defined plaits on their pillar. But the *sub-typical* group of the *Turbinellidæ* are composed of those rough, spiny, and often coronated shells, forming our genus *Scolymus:* these, therefore, are analogous to the *sub-typical* genus *Cymbiola;* and, consequently, to all such forms or types as represent them, as *Voluta imperialis*, *Harpula hebræa*, *Volutilithes musicalis*, &c. It seems to be one of the laws of variation in the structure of the zoophagous shells, that every one of the families* should contain two prominent groups; one remarkable for having smooth, and the other rough, or spiny, shells. It would even seem that Nature, so to speak, is so tenacious of this law, that she adheres to it in the very smallest of her groups, — that is, in the variations of sub-genera. Among the most common instances, the reader

* Except the *Cyprædæ*, where it is obvious, from the little variation in the shells, that the analogies must be traced from the animals only.

will call to mind the smooth and the coronated helmets (*Cassidea* and *Dolium*), the smooth *Turbinellæ*, and the murex-like *Scolyminæ*, the tuberculated *Strombi*, and the smooth Cones. The same principle, again, is often carried into the variation of each: thus, although the Cones, as a whole, are smooth shells, yet one division has coronated tubercles. Some of the melon volutes are smooth, as *V. Neptuni;* while others (which are sub-typical) are coronated. Every division, in short, large or small, in the entire family of volutes, exhibits these differences. The reader will of course understand we are now speaking only of the typical and the sub-typical types; the variation of the aberrant forms being regulated by other circumstances, which, in the present state of our inquiries, it would be premature to venture upon.

(105.) If the foregoing arrangement of the sub-generic types of *Voluta* be really natural, it follows that all the melon volutes form but one sub-genus. Break them up into other sub-genera, and give to each the same rank as attaches to the four other types, and the whole harmony and beauty of the theory would obviously be destroyed; their arrangement would then, in fact, become an arbitrary matter of nomenclature. Had our object been to have formed an artificial classification of the *Testacea*, we should, without hesitation, have adopted the views of others on this subject. The divisions of the smooth and the coronated melons are excellent, because they are natural: but all we have now stated shows that they are two sections only of a sub-genus. It will be evident to those zoologists who may be conversant with the vertebrated animals, that all groups pre-eminently typical contain a greater number of forms than any other, as if Nature intended to show us, at the onset, the rudiments of all those variations which were to characterise the surrounding groups. Lawrence, long ago, observed of the Caucasian race of man, — the most pre-eminently typical, — that it contained more numerous variations than any other; and we have shown how strictly applicable this assertion to the vertebrated animals.

Now, the melon-shells, forming our genus *Voluta*, are of this description; they stand at the head of the whole family; and we accordingly find their subordinate types are not only the most varied, but the most numerous. *Vol. imperialis*, *Scapha*, *angulata*, and *magnifica* enter, indeed, into their circle; but they do not form the *highest* point of perfection. This is seen only in the melons, strictly so termed; yet, even here, how great is the diversity of forms! We have some with a spire altogether hid, and the shell devoid of colour, as in *Neptuni;* others with the indication only of a mis-shaped spire, as in *V. Cymbium*, yet with marbled variegations: another little assemblage has coronated and vaulted spines; and even among these, the spire is so varied, that in one, *V. tessellata*, they are compressed, as it were, over an extremely short spire, which they almost hide; or, as in *diadema*, they are long, and directed forwards: finally, there is one (*V. Broderipia*) which deviates so much in its general shape and habits from all others, that it will not strictly arrange with these coronated melons, or with the next type, *V. imperialis*. Now, all these variations absolutely occur in the compass of a single sub-genus: and we may explain this diversity by supposing that the coronated melons typify the genus *Cymbiola* and *V. imperialis;* that the smooth melons are the true representatives of the whole; and that the *V. Broderipia* is an aberrant form connecting the coronated melons with *Voluta imperialis*. That such shells as *Voluta Æthiopica* are much more perfect (abstractedly) in *structure* than *Neptuni* and its allies, is unquestionable: but this does not imply *typical* perfection; for it frequently happens in aberrant groups (as the *Volutidæ* is among the *Zoophaga*), that the typical character rests on very different considerations.

(106.) It will be needless to go into all the details of the next genus, *Cymbiola*. Yet it will be satisfactory to see how intimately the types represent those of the *Voluta*,—at least, in their main characteristics. In the following table, therefore, we have selected those species

which have been already alluded to; premising only that some doubts hang over the true nature of the type which intervenes between the bat volutes (*C. vespertilio*) and *C. tuberculata*, chiefly arising from our not having these shells immediately before us. This point, therefore, must for the present be left open to doubt.*

Analogies of VOLUTA *and* CYMBIOLA *with the* GENERA.

Species of VOLUTA.	*Analogies.*	Species of CYMBIOLA.	Genera of the VOLUTINÆ.
Neptuni.	Body-whorl ventricose; shell smooth.	*Ancilla.*	VOLUTA.
Imperialis.	Shell not ventricose; whorls coronated and spined.	*Vespertilio.*	CYMBIOLA.
Scapha.	Smooth; outer lip angulated.	*Mitis.*	HARPULA.
Angulata.	Aperture effuse; spire pointed.	*Braziliensis.*	VOLUTILITHES.
Magnifica.	Sub-ventricose; apex smooth, papillary.	*Tuberculata.*	SCAPHELLA.

Cymbiola tuberculata†, from having a greater number of plaits than any other of its genus, seems to connect *Cymbiola* with *Harpula*, through the medium of *H. fulgetrum;* and at the same time to pass into *Cymbiola Braziliensis*‡; which last, by its effuse aperture, the acuminated apex of its spire, and its possessing only three plaits, is a perfect representation of *Voluta angulata*.

(107.) The genus HARPULA commences with the *Harpula fulminata*§, one of the most interesting forms in the whole family. Its shape is that of a *Fasciolaria*, the base being produced; while the apex is so papillary that it forms a large knob, almost completely round: it is, in fact, the first, or terminal, whorl which is thus inflated; and the little turn which this whorl makes is not on the top, but on the side. Now, this formation is only seen in *Scaphella papillosa*, but it is indicated in

* A full investigation of the animals of the Pacific volutes will claim our first attention, after the settlement we intend making on the romantic and prolific shores of New Zealand.

† Exotic Conch.

‡ Chemnitz, pl. 176. figs. 1695, 1696. The *Voluta rudis*, of which a figure has been published in *Griff. Cuv.* pl. 30. fig. 1., seems to me a typical melon volute; but nothing further is said about it, than that it is "clay-coloured mixed with white."

§ Ency. Méth. pl. 381. fig. 2.

H. bullata, and a very near approach to it may be traced in *Harpula vexillum*. We thus have three resemblances; one of which only we shall at present regard. The numerous plaits of *fulminata* evince its proximity to *vexillum* and *Lapponica*. To these succeed the pre-eminently typical forms composed of *Harpula hebræa, musica, polyzonalis, sulcata*, &c., all of which are thick, muricated, or spined. By these a passage is formed to those slender-ribbed species where the two last plaits are decidedly the thickest, and the upper ones either very slender, as in *Harpula lyriformis**; or nearly obsolete, as in *Harpula costata*†; or perfectly wanting, as in *Harpula nucleus*.‡ In the apex of these shells, however, here is a marked difference, plainly indicating a gradation of structure: thus, in *costata* and *multicostata*§, the apex, although obtuse, is not swelled, and the volutions appear to be graduated equally, as in *Harpula polyzonata*. In *nucleus*, the apex seems almost acute‖; but in *H. lyriformis* the second volution is swelled and papillary: it is by this shell, therefore, that we may pass to the next type of form, represented by our *Harpula bullata*¶, where the shell retains the same shape as *H. nucleus*, and, like that, has only two distinct plaits; the whole shell is quite smooth; the spire is not only very obtuse, but the terminal volution is enlarged, even in the worn individual, which is the only one we have yet seen; and its last turn is placed on the *side*, not at the *apex*. For this form, however, we have been prepared by the *Harpula lyriformis*, so that we return again to the singular-shaped spine of *Harpula fulminata*. Between *H. bullata* and *H. ful-*

* Zool. Journ. iii. pl. 3. Zool. Illust., first series, pl. 54.
† Brand's Journal, xvii. p. 33.
‡ Mawe's Conchology, frontisp. fig. 2.
§ Broderip, in Zool. Journ. iii. pl. 3. fig. 2.
‖ I am not positive on this, not having a perfect example at this time before me.
¶ The only specimen I have yet seen of this shell is figured in *Zool. Ill.* 2d series, pl. 15.; nor am I aware of any other, at least in the London cabinets. Papillary spires are always remarkably thick; and as it was evident this specimen had been beaten and battered on the sea beach, it is highly probable that the apex was originally much more thick and inflated than it was on coming to my hands. It is now in the British Museum.

minata we are disposed to place a most singular volute, described with Mr. Broderip's usual accuracy, which partakes both of one and the other. It has, in fact, almost precisely the same elongated shape as a young specimen of *fulminata,* before the outer lip has been formed; while the number of its plaits are only *two,* thus agreeing with *bullata.* Divest the *fulminata** of its outer lip, and it would have the same "fig-like" appearance as Mr. Broderip's *H. dubia.*† That the plaits on the pillar of some of these shells increase with age, is proved by a young *H. vexillum,* now before us, which has only four, instead of eight.

(108.) In this manner, as it appears, the genus HARPULA forms a circular group, which, by commencing with *H. fulminata,* passes onward to *Lapponica* and *vexillum,* and from thence to *hebræa : polyzonata* conducts us to *costata;* and *lyriformis* to *nucleus* and *bullata;* while *dubia* brings us again to *fulminata.* We may now compare the contents of this circle with the last.

Analogies of the Genus HARPULA.

Sub-generic Types of HARPULA.	*Analogies.*	Genera of the VOLUTINÆ.	Sub-generic Types of VOLUTA.
H. fulminata.	Lower plaits of the pillar small.	SCAPHELLA.	*Magnifica.*
vexillum.	Shells smooth.	VOLUTA.	*Neptuni.*
hebræa.	Shells muricated or nodulous; apex obtuse, but not much enlarged.	CYMBIOLA.	*Imperialis.*
costata.	Plaits numerous, the lower largest; apex variable.	HARPULA.	*Scapha.*
bullata.	Plaits on the pillar very few.	VOLUTILITHES.	*Angulata.*

* I have recently come to a knowledge of the habitat of this shell, which is Java.

† As Mr. Broderip's observations on this shell will be much more valuable than my own, the reader will be better pleased by perusing that acute naturalist's own words. "This shell is one of those forms which convince us of the vanity of our artificial distinctions. When viewed from above, it seems as if the spire of a *Voluta* were placed on the body-whorl of one of those *Pyrulæ* which are commonly known by the name of *Figs.* Turn it, and the difficulty of classing the shell is rather increased; for the aperture is still fig-like, and it requires an accurate examination to detect the two almost imperceptible plaits on the columella. The apex, indeed, uncouth as it is, shows more like that of a *Voluta* than of any other shell, and it is utterly different from that of a *Pyrula.* Place it among the volutes, and it will be found to approach nearest to *V. rupestris;* though one cannot but suspect that there are yet, in the bosom of the deep, many gradations of form between them. There is, I believe, one specimen in the cabinet of prince Massina."—*Brod.,* in *Zool. Journ.* iii. p. 81. pl. 3. fig. 1.

Of the resemblance between the three first, or *fulminata*, SCAPHELLA, and *magnifica*, we shall have to speak hereafter. The group which contains *Harpula vexillum* and *Lapponica*, as clearly represent the smooth melons, as *hebræa* does the bat volutes (*Cymbiola*). There is a circumstance, also, regarding *H. vexillum* and *Lapponica*, apparently trivial, but of peculiar interest to those who delight in analogical researches: they are the types of the genus *Harpula*, which, as a whole, we have shown to correspond with the *Strombidæ*; and, in proof of this, we remarked that the major part presented the analogous character of the outer lip being carried upwards towards the spire. But this is not the only analogy: at the base of the outer lip, in fine and uninjured specimens of *vexillum* and *Lapponica*, is a slight but very distinct *sinus**, rudimentary, as it were, of the distinct lobe in the genuine *Strombi*: this is not seen in the next division, represented by *H. hebræa*; but then, again, these latter shells have the top of the outer lip much more advanced on the spire. *Costata* not only represents, but is actually one of, the *Harpulæ*; while *Volutilithes*, with its few plaits, is equally represented by *bullata* or *nucleus*.

(109.) The types of form in VOLUTILITHES will now be inquired into. Throughout all the species we have seen, or which have been figured, the typical structure, in regard to the paucity of plaits and the acuteness of the spire, seems almost universal. The first group which unites these sharp-pointed volutes with *H. lyriformis*, seems to be such shells as *V. costaria*†, which, by a series of other species furnished with distinct convex ribs, like those of *H. lyriformis*, lead us, by means of *muricina*‡, to *musicalis* and *spinosa* § (*fig.* 12. *c*, in p. 123.): a third type is represented by the *crenulata* and *bicorona* || Lam.; a fourth by his *rarispina*; and the

* This is precisely analogous to the corresponding prototypes, *Rhinedomus* and *Cyllene*.

† Ency. Méth. pl. 383. fig. 9.

‡ Ibid. pl. 383. fig. 1. *a*, and pl. 384. fig. 3.

§ Ibid. pl. 392. figs. 4, 5.

|| Ibid. pl. 384. figs. 5, 6.

fifth, which so singularly represents *Voluta angulata* and *Cymbiola Braziliensis* (no less than the *Pyrulæ*), is seen in *V. cithera**, this latter being the second type of the genus.

(110.) That there exists mutual resemblances between these presumed types, and those of the three preceding genera, will be evident from the following comparison:—

Analogies of the Genus VOLUTILITHES.

Sub-generic Types of VOLUTILITHES.	*Analogical Characters.*	Types of HARPULA.	Genera of the VOLUTINÆ.
Spinosa.†	Shell partially or wholly smooth.‡	*Vexillum.*	VOLUTA.
Crenulata.	Shell entirely muricated.	*Hebræa.*	CYMBIUM.
Costaria.	Spire much lengthened; outer lip well developed; apex sometimes slightly enlarged.§	*Lyriformis.*	HARPULA.
Cithera.	Ventricose; spire very short.	*Bullata.*	VOLUTILITHES.
Rarispina.	Analogous to the *Strombidæ;* outer lip sinuated at the base, and often detached above.	*Fulminata.*	SCAPHELLA.

Perhaps it may eventually turn out that the *V. musicalis* ‖ — a species we do not possess in perfection — is one of the typical forms, and that *spinosa* is the other: but the very singular-grooved suture of *costaria* and *bicorona* appears to indicate that a peculiarity of structure existed in the animal, of more importance than the mere form of the shell. The analogy, or rather the affinity, between *costaria* and the *Harpulæ* must be apparent to every one, no less than that between *Voluta angulata, Cymbiola Braziliensis,* and *Volutilithes cithera.* Of

* Ency. Méth. pl. 384. fig. 1.

† It is not a little remarkable, that, in well-preserved specimens of the fossil species from France, the body-whorl is marked by transverse orange lines, completely analogous to *H. vexillum.*

‡ If, as may be suspected, the *Voluta labrella* (Ency. Méth. pl. 384. fig. 3.) is the true type of this division, then its analogy to the smooth melons would be perfect, inasmuch as this fossil is entirely without the muricated spines of *spinosa:* I do not, however, feel at all satisfied that I have correctly indicated this and the next type.

§ As in the two species here compared.

‖ Ency. Méth. pl. 392. fig. 4.

V. rarispina we can only form our conclusions from the figure in *Ency. Méth.* 384. fig. 2. It would seem from this, that there is a very distinct sinus at the base of the outer lip, while the wide-spread deposition of enamel on the inner lip reminds us both of the genus *Marginella* and of *Voluta Scapha:* it is, in short, the strombiform type.

(111.) We now come to the last genus, SCAPHELLA. Although these shells are readily distinguished by the experienced malacologist at the first glance, it is not so easy to define them by words. Their true characters, we apprehend, will be found in the animal. They differ from all other known volutes, by being always without sculpture, and generally polished like the *Marginellæ.* The apex of the spire varies precisely in the same way as in the genus *Harpula:* in the chief type, represented by *S. undulata,* it is small, and obtusely pointed. In *fusiformis,* it is decidedly thick; and in *papillosa,* it becomes exceedingly large and round. A shelly deposition is often formed in mature age, at that part of the outer lip which joins the spire, and also on the pillar side of the aperture: there is a constant propensity, in short, to this thickening of the pillar, even in shells which usually have their plaits distinct. The first advance to this structure, after leaving the last genus, is by a very singular fossil shell, described by Lamarck as the *Buccinum strombioïdes.*

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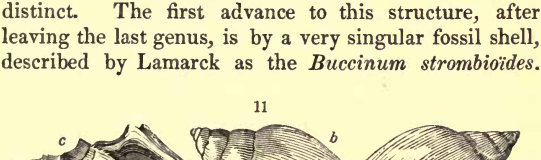


(*fig.* 12. *a, b.*) Mr. G. B. Sowerby, in adopting this name, justly observes, that, but for the absence of folds on the

pillar, its characters are more like those of a volute than a *Strombus*. One circumstance, however, not noticed by either of these writers, must be here mentioned: the whole shell is covered with a thin coat of shining enamel, as in some of the recent *Scaphellæ*, particularly thick at the top of the outer lip. This is always apparent; while, in old ones, there is also a thick deposition on the upper part of the inner lip, which spreads over all the under side of the body-whorl. This, in fact, is but a slighter developement of that greater thickening of enamel seen in the last shell we spoke of,—namely, the *Volutilithes rarispina;* and is precisely what might be expected in any type which was to connect it with the genus *Scaphella*. The absence of plaits on the pillar of this interesting shell (which for the present we shall call *Scaphella stromboïdes*) will not be at all incongruous, — because, in the whole of the *Volutilithes*, these appendages are small, and frequently almost evanescent; while the detachment of the upper part of the outer lip from the spire plainly shows it is the strombiform type of this genus, as *V. rarispina* is of the last.

(112.) *Scaphella* being thus connected to *Volutilithes*, we may pass over the two chief types, represented by *S. undulata* and *fusiformis*, and recall the reader's attention to the next in the series, — namely, *Scaphella papillosa*, formerly alluded to. Now, there are two other shells which more especially possess this kind of nipple-like apex, and in the same high developement,— the *Harpula fulminata*, and the *Voluta fulgetrum:* the question, therefore, is, to which of these is it mostly allied? On this point we reply,—to the latter by affinity, and to the former by analogy. It thus follows that we have traced the series of the volutes once more up to the typical genus, which we enter again by means of *Voluta fulgetrum* and *magnifica*.

(113.) The four types of *Scaphella*, which are all we at present know, will thus find their respective analogies.

Analogies of the Genus SCAPHELLA.

Types of SCAPHELLA.	*Analogical Characters.*	Types of VOLUTILITHES.	Types of VOLUTA.
Undulata.	Shell very smooth; suture enamelled; spire small.	*Crenidata.*	*Cymbiola.*
Fusiformis.	Sub-ventricose; spire thick.	*Labrella?*	*Neptuni.*
Papillosa.	Tip of the spire thick and mammillary.	*Costaria.*	*Magnifica.*
?	?	*Cithara.*	*Angulata.*
Stromboïdes.	Inner lip thickened and gibbous near the spire; outer lip angular and prominent above.	*Rarispina.*	*Scapha.*

(114.) This is the proper place for remarking a peculiarity in *Volutilithes costaria,* which we have not observed in its allies; the apex, although pointed, has one of the volutions thickened,— so that, in its own circle, it becomes exactly what *papillosa* is among the *Scaphellæ.*

(115.) The peculiarly strong resemblance, however, between *Scaphella papillosa* and *Harpula fulminata,* is too remarkable to be termed a simple analogy. This brings us to another peculiarity of the natural system, of which full explanations and numerous proofs have been adduced in our former volumes.* The study of the different classes of the vertebrated animals, however, is quite out of the province of the malacologist, and we cannot suppose that he will assent to so novel a theory, unless it be proved in his own particular walk. We therefore lay before him, as a case in point, the aberrant groups of the *Volutinæ,*—namely, *Harpula, Volutilithes,* and *Scaphella.* The series in which we have placed these, commences with *Harpula fulminata,* and terminates with *Scaphella papillosa.* Is there not sufficient evidence that these two extremes meet? and that *Scaphella papillosa* is as nearly related to *H. fulminata* as to *Voluta fulgens?* If so, our series forms a circle. Thus, we find the whole family — as we began with assuming — constitutes one circular group, primarily

* Geography and Classification of Animals, p. 226.

divided into three other circles, — the first of which, *Voluta*, is typical; the second, *Cymbiola*, is sub-typical; and the third, which contains *Harpula*, *Volutilithes*, and *Scaphella*, constitutes the aberrant circle. This, in fact, is only in conformity with all other natural groups in the *Vertebrata*; so that, if the principles upon which we have now arranged the *Volutinæ* are radically defective, so also are those in the innumerable groups that have been thus tested and verified in ornithology, ichthyology, &c.: for it is logically certain, that *unity of plan* cannot exist in the animal world, if one and the same principle of variation is not fundamental, and does not pervade all its parts.

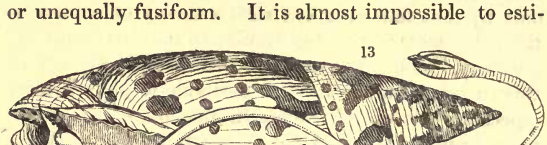
(116.) The MITRINÆ, or mitres, no less than the volutes, are characterised, in the great majority of the species, by very distinct and tangible characters; but so soon as we reach the extreme limits of each, and look for those marks by which we have been accustomed to separate, with ease, the two groups, we find some of them gradually disappear, and others so modified and interchanged as to render it very difficult for an ordinary naturalist to draw any positive line of demarcation, — at least, on those principles of absolute division insisted upon by some writers. It has, for instance, been thought that a shell having the spire papillary, and the lower plaits upon the pillar largest, was unquestionably a volute: and yet we have, in *Volutilithes*, a whole assemblage of shells whose apex is acute; and in another group, *Scaphella*, the lower plait is always the smallest. Among the mitres, on the other hand, we shall find more than one with a papillary spire, and others where the lower plaits are as large as the upper. Hence it follows, that if no groups are to receive generic or family names, but such as are distinctly separated, and are destitute of these intervening links, the old genera of *Voluta* and *Mitra* must again be united. Nor should we stop here: *Mitrella* so connects the mitres with the olives, that those, too, must be absorbed in this gathering conchological snowball; and

with *Oliva* must follow *Ancillaria:* in this way we might go on until we have but one genus, *Voluta.* It is only by thus following out such a theory of nomenclature, that we see the full results to which it must, of necessity, lead. We have, indeed, already spoken on this subject; but we think it desirable to place it more especially before our readers in this place, where the opposite plan has been so prominently brought forward.

(117.) The whole of the MITRINÆ, or Lamarckian mitres, were considered but as one genus until about twenty years ago, when we ventured to detach from them a small group by the name of *Conchelix.* Nearly as great opposition was manifested to this innovation, as has recently been made in respect to *Cyprœcassis*, but this, of course, was to be expected from those conchologists who looked only for "well-marked and absolute divisions:" the group, however, was soon taken up by the Continental naturalists, and is now generally adopted. Having always had a peculiar fondness — almost a passion — for these elegant shells, we continued their study, until, in 1827, our investigations had proceeded so far that we ventured to characterise the five leading divisions, or genera. The great number of new species discovered by Mr. Cummin, added to others continually coming before us, naturally led to a still more close analysis of the whole. The result of this, in regard to the *theory of variation,* was communicated to the Zoological Society in 1835.* This theory is now found to pervade the whole class of *Testacea*; while, in our *Systematic Arrangement,* will be found all the well-known and clearly described species, distributed under their several minor groups. The *Mitrinæ,* in comparison to the volutes, with two or three exceptions, are much smaller shells, chiefly distinguished by the smaller size of the foot, as in *Mitra episcopalis* (*fig.* 13.), where the proboscis is excessively long; and by the greater length of their spire, the tip of which is never papillary.† The

* Proceedings of the Zool. Society, part iii. p. 197.
† Except in two or three species of *Mitreola,* which blend into *Harpula.*

upper plaits of the pillar, in almost all, are larger than the lower; and the general form of the shell is equally or unequally fusiform. It is almost impossible to esti-



mate the number of species, as new ones are constantly coming to light; but there probably exists already, in our cabinets, about two hundred and fifty, of which more than forty were brought home by Mr. Cummin from the western coast of Tropical America. We suspect, from these data, that, in a few years, the increase of known species will come near to 300, leaving out those that belong to the three aberrant genera — *Mitrella*, *Conœhelix*, and *Mitreola*. Nearly all these are excluded from the European seas; and, what is still more extraordinary, not more than half a dozen can be called common shells. This scarcity of mitres certainly does not originate from the difficulty of gaining access to their haunts; for, although some are known to live at great depths*, yet both MM. Stuchbury and Cummin inform us that they generally found these shell-fish in shallow water, near coral reefs. Hence we conjecture that their chief metropolis must be the great Pacific Ocean, where, among the countless numbers of existing islands, and the coral foundations of others, the number of species now unknown may be nearly equal to those already described. The animals of a very few have been published by M. Quoy, in the invaluable plates of his voyage; for the particulars of which we have not sufficient space.

(118.) The primary divisions of the whole of the family, as already intimated, correspond with those of

* As *Mitra zonata*, which, Dr. Leach says, was fished up out of very deep water near Nice.

genera of the volutes; and they may be thus briefly characterised from their shells. The most typical is — 1. *Mitra*, where the basal whorl is somewhat ventricose, and the aperture has no internal groove. 2. *Tiara* (*fig.* 14.), having the basal whorl contracted, and the internal groove distinct;—this is the sub-typical genus. The 3d, or next, *Mitrella*, resembles the olives in being smooth, and in having the base of the pillar thickened, with the plaits very much projecting. In the 4th, or *Conœhelix*, the spire is very short, the plaits numerous, and sometimes indistinct: whereas, in the 5th, or *Mitreola*, the upper plaits are smallest, the outer lip inflected and sometimes toothed, and the spire slightly papillary. As all these peculiarities will be detailed in the next division of our volume, we shall here only make a few general observations on the contents of the genera; and first, with regard to

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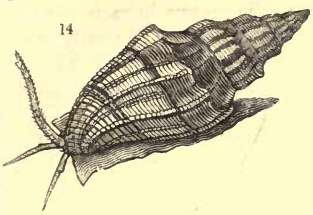


The Analogies of the VOLUTINÆ *and the* MITRINÆ.

Genera of the *Mitrinæ*.	*Analogical Characters.*	Genera of the *Volutinæ*.
MITRA.	Body-whorl never contracted at the base; the whorls never turreted or angulated.	VOLUTA.
TIARA.	Shell turreted; body-whorl contracted in the middle; the whorls nodulous or sub-coronated, or carinated, rarely smooth.	CYMBIOLA.
MITREOLA.	The upper plaits on the pillar smaller than those in the middle; spire sometimes papillary.	HARPULA.
CONŒHELIX.	Spire very short; plaits very slender, sometimes obsolete; surface generally reticulated or striated.	VOLUTILITHES.
MITRELLA.	Smooth, generally polished; the lower plaits smaller than the upper.	SCAPHELLA.

We shall make no other commentary upon this table, than as regards the rank of the groups in each column, which are thus shown to be genera. The *sub*-genera of the *Volutinæ*, it will be remembered, we have indicated, but not named, because the species they contain are so few, and these so well known, that it might be thought a needless multiplication of names. But in the present family the case is widely different: as not one third of the mitres are figured, and the descriptions of most of the remainder are too vague to admit of determination, it becomes absolutely necessary, not only to characterise, but to name, the sub-genera. This we have accordingly done,—confining ourselves, however, to the two typical genera, which, as in all such groups, contain the great majority of the species. The foregoing table shows that *Mitra* and *Tiara* are the two groups in question; and, as the definitions of their sub-genera will be hereafter detailed, we shall at once lay before the reader the exposition of their analogies.

Analogies of the Genera MITRA *and* TIARA.

Sub-genera of *Mitra*. Internal canal wanting; aperture smooth.	*Analogical Characters.*	Sub-genera of *Thiara*. With an internal canal; aperture striated.
Mitra.	Spire and aperture of equal length, unequally fusiform; body-whorl obtuse.	*Costellaria.*
Tiarella.	Shell with distinctly coronated, acute, or obtuse tubercles.	*Tiara.*
Scabricola.	Shell with numerous elevated ribs, longitudinal in one, transverse in the other.	*Callithea.*
Nebularia.	Shell reticulated or cancellated; the base of the aperture effuse.	*Cancilla.*
Strigatella.	Size very small; outer lip thickened, and generally gibbous within.	*Pusia.*

It thus appears that each of the divisions, or sub-genera, of *Mitra* finds its representative in *Tiara;* and that, without a due regard to the essential characters which distinguish these two genera, it will be impossible

to know to which of them a Lamarckian *Mitra* really belongs. We are sorry, indeed, to impose so much trouble upon collectors; but the blame, if any, must be laid upon Nature—not us: for we merely endeavour to trace her steps. But she does not stop here. Into each of these sub-genera, which happen to be full of species, she actually carries the same principles of variation; so that, if all the shells really belonging to our sub-genus *Mitra*, even as now restricted, were spread before the naturalist, he would find not very incipient characters of every one of the sub-genera just enumerated; and this, to such an extent as to justify our reaching this conclusion,—that if the whole of the species that have been created were known, every *Mitra* would have its counterpart, or prototype, in the circle of *Tiara*. Any naturalist may convince himself of this, by looking to the five sectional types of the sub-genus *Mitra*, for instance, as *episcopalis*, *ruffina*, *punctata*, *lactea*, and *zonata*. The second represents *Tiarella* by its crenated suture; the third shows us the roughness of *Scabricola;* the fourth the effuse aperture of *Nebularia;* and the fifth the dingy colour and thick epidermis of *Strigatella*. The *Mitra terebralis* and the *Tiara terebralis** are counterparts of each other, and are only prototypes, under a different form, of the genera *Terebra* and *Turritella*. We regret exceedingly that we cannot give as full an exposition of the mitres as we have done of the volutes: half a volume would hardly be sufficient. It seemed preferable fully to detail our analysis of the first, as being the typical group; and because, from the comparative paucity of the species, the natural series became more difficult to demonstrate than that of the mitres. Now, as the principle of variation in each is precisely the same, we have given only the results of

* Of this shell, Mr. Broderip justly observes, "It is one of the most slender of its genus, and has very much the general character and form of a *Terebra:* this resemblance is increased by the circumstance of its having one spiral groove more deeply impressed than the others, placed at about one third of the length of each volution before the suture."—*Proc. Zool. Soc.* part iii. 1835, p. 196.

our investigation in the mitres. Whether we view the family *Volutidæ* as a whole, or contemplate separately each of its divisions, whether large or small, we shall find their variation uniformly harmonising with what has been seen in the *Muricidæ* and the *Turbinellidæ*,—a fact which every one will perceive, on investigating the following table, which is also sufficient to furnish the clue even to the analogies of the sub-genera.

General Analogies of the VOLUTIDÆ.

Families of the ZOOPHAGA.	Sub-families of the *Volutidæ*.	Genera of the *Volutinæ*.	Genera of the *Mitrinæ*.	Sub-families of the *Muricidæ*.	Sub-families of the *Turbinellidæ*.
TURBINELLIDÆ.	VOLUTINÆ.	*Voluta*.	*Mitra*.	CASSINÆ.	TURBINELLINÆ.
MURICIDÆ.	MITRINÆ.	*Cymbiola*.	*Tiara*.	MURICINÆ.	SCOLYMINÆ.
VOLUTIDÆ.	OLIVINÆ.	*Harpula*.	*Mitreola*.	BUCCININÆ.	FUSINÆ.
CYPRÆIDÆ.	ANCILLARINÆ.	*Volutilithes*.	*Conchelix*.	PURPURINÆ.	PYRULINÆ.
STROMBIDÆ.	MARGINELLINÆ.	*Scaphella*.	*Mitrella*.	NASSINÆ.	EBURNINÆ.

(119.) The three aberrant divisions of the volutes, namely, the OLIVINÆ, the ANCILLARINÆ, and the MARGELLINÆ, must be dismissed in a few words. The minor variations in each are very few, and will be found in the systematic arrangement. The genus *Mitrella* leads us immediately from the mitres to the olives; where, as in *Harpula*, the plaits upon the pillar cover the whole length of the inner lip: the foot of the animal is excessively large, and sufficiently dilated to fold over the greater part of the shell; but the mantle is not lobed. The first genus is *Lamprodoma**, which chiefly differs from *Mitrella* in having the channeled suture so universal among the olives. This leads to the typical genus *Oliva*, wherein the majority of the species are still arranged. *Scaphula*, by its thick undefined spire and ventricose body-whorl, is a complete prototype of the melon volutes, and prepares us for *Hiatula*, in which the characters of *Oliva*, *Scaphula*, and *Ancillaria* are combined. The circle is then closed by those small species arranged under the genus *Olivella*, wherein the base of

* *Lamp. Olivella*, Zool. Ill. ii. pl. 40. fig. 1.

the aperture is only effuse, and the spire as much lengthened, as in *Lamprodoma:* the plaits on the pillar, like those on *Volutilithes,* are reduced to their *minimum;* the two last are the strongest, the others nearly obsolete. It is by this particular group that the VOLUTIDÆ and the TURBINELLIDÆ are united; the direct passage being marked by *Olivella biplicata* Sw. in one, and *Pseudoliva plumbea* Sw. in the other. (*fig. 3.* at p. 82.) The olives are among the best known, the most polished, and the most variable shells in this family. They swarm in the seas of tropical climates, more especially in the East, but seem altogether excluded from the European coasts.

(120.) The forms, or variations, among the ANCILLARINÆ are as yet too few to render it necessary to create sub-divisions: the beautiful analogy which this group bears to the *Purpurinæ,* by the prominent little tooth on the outer lip, as well as by the width of its aperture, must not be overlooked; while the high polish of all the species, the general shortness of the spire, and the unusual thickness of the base of the inner lip, are so many points of resemblance to the *Cypræidæ.*

(121.) Finally, the MARGINELLIDÆ are the smallest shells, as to size, in the whole family: they are at once distinguished by their thickened outer lip; but they all vary in the absence or developement of the spire and of the inner lip, as well as in the plaits of the pillar: hence their genera may be sufficiently defined. Their union with the *Volutinæ,* by means of *Scaphella Zebra*,* is clearly shown by our genus *Glabella,* where the inner lip is either entirely wanting or but slightly developed: these latter conduct to *Volutella,* which, by its obsolete spire, preserves a strong analogy to the melons. In *Persicola* we have a prototype of *Conchelix;* while the typical form, *Marginella,* has the inner lip so much developed, as to form a thickened deposition all round the aperture. On the fifth type we feel some uncer-

* Placed among the *Marginellæ* by Lamarck.

tainty ; but we think it is represented by those species which have the outer lip gibbous above, analogous to *Voluta Scapha* and other strombiform types ; or it may possibly be Lamarck's fossil genus *Volvaria*. It is easy to perceive, however, how strikingly this sub-family, as a whole, represents the *Nassinæ*, the *Eburninæ*, and the *Columbellinæ*, all which are prototypes of the *Strombidæ*.

(122.) We shall conclude our exposition of this interesting family by what may be called a continuation of the last diagram, for the purpose of illustrating certain analogies in regard to the animals.

Analogies of the VOLUTIDÆ *to Vertebrated and Annulose Animals.*

Genera of the *Volutinæ*.	Sub-families of the *Muricidæ*.	Families of the *Phitophaga*.	Tribes of the *Dithyra*.	Classes of *Animals*.	Classes of *Insects*.
Voluta.	*Cassinæ*.	*Trochidæ*.	ATRACHIA.	MAMMALIA.	APTERA.
Cymbiola.	*Muricinæ*.	*Helicidæ*.	MACROTRACHIA.	AVES.	PTILOTA.
Harpula.	*Buccininæ*.	*Turbidæ*.	TUBULIBRANCHIA.	REPTILIA.	ANNELIDES.
Volutilithes.	*Purpurinæ*.	*Naticidæ*.	CHELISOMA.	AMPHIBIA.	VERMES.
Scaphella.	*Nassinæ*.	*Haltotidæ*.	BRANCHIOPODA.	PISCES.	CIRRIPEDES.

It is chiefly with reference to the fifth set of types, which contains the longest-bodied animals in all these circles, that we have drawn up this table. A peculiarity is of course shown in the *Testacea*, by the prolongation of the spiral whorls : hence we find the longest-spired volutes are in the genus *Harpula*. The *Buccininæ* contains *Terebra ;* and the genus *Turritella* is the type of the *Turbidæ*. Continuing this analogy on to the bivalves (*Dithyra*), we have the long tubular snake-like shells of the *Tubulibranchia*, representing the real serpents among vertebrated animals, and the *Annelides* among the annulose or insect tribes. The excessive developement of the organs of locomotion, or *foot*, as shown in the first set of analogies, is most remarkable. But as a chapter would be insufficient to illustrate the innumerable analogies concentrated in this

table, we must leave it, as a fruitful and untrodden field to those who wish to prosecute its study.

(123.) The passage to the CYPRÆIDÆ is so well marked by those *Marginellinæ* which have the spire completely hidden, as to leave no doubt of the cowries following the volutes. We must, for want of space, omit the accounts of the animals of the two typical divisions, *Cypræa* and *Ovula*, now well known by the excellent descriptions of MM. Quoy and Gaimard: suffice it to observe, they have some things in common with the volutes; — the foot is very large, and the tentacula short: the mantle is dilated into two large lobes, almost sufficient to cover the shell entirely, — their junction being marked by a pale line down the back, where the colour often appears as if faded. The *Cyprœinæ*, or cowries, form the typical, and the *Ovulinæ*, or egg-shells, the subtypical, group. The former are well known as among the most elegant and richly coloured of the *Testacea;* always having the spire concealed, and generally oniscifform, — that is, oval, and flattened beneath. The species are particularly numerous in tropical latitudes, and several are among the most common shells in our collections: they have been very ably investigated by Mr. Gray, who has judiciously characterised and named some of the types; for they were all left by Lamarck in one genus. The *Ovulinæ* resemble in general form the cowries; but the extremities of the aperture are generally produced, and there are no teeth on the inner lip. Not having yet investigated this division, we shall for the present leave it as it is, and merely notice those which seem to be the aberrant genera, connecting this family, on one side, to the *Volutidæ*, and, on the other, to the *Strombidæ*. The first we conjecture to be the fossil genus *Volvaria*, as well defined by Mr. Sowerby*; while the latter union appears to be affected by *Erato*, where the general shape is that of a *Columbella*, but with the dorsal sulcated line of *Trivea:* between this we are disposed to place, under the name of *Cylindrella*, two or three

* Genera of Shells.

small shells resembling *Volvaria* in form, but destitute of any plaits upon the inner lip. The *Cyprœidæ* will thus form a group far less perfect in its contents than the *Volutidæ*, yet sufficiently marked to constitute it circular.

CHAP. V.

THE PREDACEOUS GASTROPODS CONTINUED.—THE STROMBIDÆ, OR WING-SHELLS.

(124.) THE STROMBIDÆ is one of the most varied of the predaceous families, not so much in the structure of the animals, as in their shells. The typical group, indeed, is very peculiar in both respects; but the animals of the rest, with which we are as yet acquainted, have a much greater sameness than would have been expected from the marked difference in their habitations. In regard to the first, the most prevalent character appears to be the pedunculated nature of the eyes, which are generally situated about midway upon the tentacula—never at their base, or at their tips. In the typical *Strombi*, these organs are so much developed, that the iris is richly coloured; and the eyes of some of the large species have been described to us as particularly beautiful. The shells present every variety of the spiral form, excepting that they are never depressed; yet, throughout the whole, one character may be traced: the outer lip is either enlarged, thickened, or expanded; or, if not so, the upper part is detached from the spiral whorl, so as to form a wing-like or angular projection; hence their common name of *wing*-shells: all are furnished with a small operculum, and are strictly external shells. In the Lamarckian genera *Strombus*, *Conus*, *Columbella*, *Pleurotoma*, and *Cerithium*, the student will see the five principal types.

(125.) The rank of the group being that of a family, its first divisions, just mentioned, become sub-families. 1. The *Strombinæ*, or true wing-shells, having the outer lip greatly dilated, with a lobe at the base, and often on the summit also, of the outer lip; the spire being always more or less elevated. 2. The *Coninæ*, or Cones, where the spire is so depressed as to be turbinated, and scarcely raised above the body-whorl: the aperture is always smooth; the outer lip without any lobe, and only slightly detached above. 3. The *Columbellinæ*, or dove-shells, small in size, and with short-pointed spires; the outer lip is thick, turned inwards, more or less toothed on its edge, and gibbous above; there are also tuberculated teeth at the base of the inner lip, but no regular plaits. 4. The *Pleurotominæ*, or slit-shells,—so called from a deep lobe, or slit, at the top of the outer lip: the spire, in general, is very long, and the shells themselves often spindle-shaped. 5. The *Cerithinæ*, called club-shells, from their clavate form: the body-whorl is not much larger than the one which precedes it; but the outer lip is slightly detached above, and then much dilated; the basal canal, which is always very short, is generally more or less turned backwards.

(126.) These primary divisions appear to form a circular series, and to be united in the following manner:—Commencing with the *Strombinæ*, we pass from them to the *Cerithinæ*, by means of that well-known shell the *S. pes-pelicani* of Linnæus, which, in its immature state, before its lip has expanded, might easily be mistaken for a young *Cerithium*. Next to these latter, Lamarck places the *Pleurotominæ*; their junction being formed by his *Clavatula*, and the genus *Potomis*: with these, again, a union is rendered absolutely perfect with the *Columbinæ*, by means of certain genera now defined for the first time: others of the *Columbinæ* so strikingly resemble small cones, that but for a close inspection, they could not be distinguished. From the cones we pass to the singular genus *Terebellum*,

which brings us once more to the *Strombinæ;* and terminates the series. We shall now take each of these sub-families in succession, and lay before the reader the result of the closest analysis we have been able to give them.

(127.) The STROMBINÆ, or true wing-shells, are obviously the pre-eminent typical group; and consequently stand at the head of the family. The great expansion of the outer lip in all the genera, save one (*Strombidea**), which connects them to *Terebellum*, is their best, and, indeed, their only general, distinction. The genera are five: *Strombus, Strombidea, Rostellaria, Aporrhais,* and *Pterocera;* all of which are easily recognised. The most typical, perhaps, is *Pterocera,* where the outer lip is expanded, in mature age, into very long claw-like processes, which gives them something the appearance of scorpions, with the legs, on one side, stretched out, and those of the other concealed; but their chief characters seem to rest on the basal lobe of the outer lip being turned inwards, and generally toothed. This character, hitherto overlooked, has caused two of the sub-generic types to be placed with the Lamarckian *Strombi;* and hence the latter has been overburdened with shells which, we think, do not naturally belong to it. The first, or typical, form is seen in *P. lambis,* where the processes of the lip are all pointed in one direction; and the basal canal, which is considerably lengthened, is curved only on its terminal half. The second is the *P. millipeda,*—differing from the last, not only in the greater number of the processes, but in those adjoining the spire being more united together at their base; or, in other words, the divisions are not so deeply cleft. This type prepares us for the third, which has all the characters of *Pterocera,* except that the lateral processes are wanting, and the upper are only indicated by deep lobes: the only example yet known, is the shell we formerly figured under the name of *Strombus sinu-*

* Represented by *Str. urceus* and its allies.

atus, but which we now remove to the present genus. This we also do with the *Strombus latissimus* of authors, which constitutes our fourth type. This remarkable shell immediately follows the *Pterocera sinuata ;* and although the digitations no longer appear, they are slightly indicated by little folds : the side of the outer lip, as in all the other types, is broadly reflected inwards. In the fifth and last form, as seen in *P. chiragra*, the digitations are again developed ; but they are fewer in number, and of nearly equal length. In this type, also, the basal channel is recurved outward ; and the sinus on the lip is so remote from the base, as to admit of an intervening process.

(128.) The restricted genus *Strombus* follows that of *Pterocera ;* it is distinguished by the outer lip being entire, much dilated, and always furnished with sinuosities, or lobes, both above and below : the base is short, and slightly turned upwards. In this genus there are five distinct modifications. The *Pterocera sinuata* leads us immediately to the first type, which is composed of *S. melanostomus, pacificus, Auris-Dianæ* Linn., and *Lamarckii.** In all these, we trace the last remnant of the character of *Pterocera*,—namely, the folding back of the outer lip, which is particularly conspicuous in our *S. melanostomus* and *Pacificus :* the upper part, also, is prolonged into a lengthened process. As a group, it is at once known by the basal canal being turned back, as in the *Cerithinæ*, or rabbit-shells. From these, by means of *S. tricornis* and *Gallus*, we are brought to the beautiful pink-mouthed *S. gigas*, and the rare *S. Goliathus*, where the lip may be said to have attained its *maximum*. In *Accipiter* and *Canarum*, it assumes the shorter and more wing-like form of the type which succeeds this : all these, with *Strombus granulatus*, &c., and, finally, *Epidromus*, seem, to us, to constitute a second type of form, wherein the outer lip is particularly large and spreading, yet without that short sinus, or

* I know not who has affixed this name to what was considered the smooth variety of *Auris-Dianæ*.

lobe, which is so prevalent in the next group. This lobe is most conspicuous in *S. lentiginosus*, where, in fact, there are two ; as is the case, also, in our *S. Gallus* and *tuberculatus ;* but in *minimus*, *variabilis*, &c., the lobe is less apparent. Yet, in all these, the outer lip, although large, is not reflected, but takes a curve inwards. The fourth type is seen in *S. gibberulus*, which is remarkable for the shortness and distortion of the spiral whorls, and the very slight expansion of the outer lip: it is chiefly remarkable, however, for a thickened deposition of enamel at the top of the inner lip, analogous to that in *Nassa*, *Oliva*, &c. These are connected to the last by *Luhuanus*, which has the distorted spire, but not the other characters, of *gibberulus*. The fifth and last type is seen in the *Strombus succinctus*, remarkable for the prolongation of the lip, very high upon the spire, so that it becomes a perfect representation, in this group, of *Rostellaria*.

(129.) The next genus is *Strombidea*,— a name we give to all those small shells, which, like *S. urceus* and its congeners, have the outer lip merely lobed at the base, without being detached, or dilated above. We take some blame to ourselves, for not having long ago perceived that these shells were not true *Strombi ;* but we had then only analysed the family in part ; and, as usual in such cases, we subsequently found that we were in error.* The *Strombidea*, in short, are prototypes of the *Columbellinæ ;* and so strong is this analogy, that our *S. crassilabis* was sent to us as a *Columbella*.

(130.) The genus *Rostellaria* contains some few of the most elegant and costly, if not the most beautiful, shells in this family: it is, therefore, very interesting, even to the conchologist ; but it is particularly so with reference to its types. The primary distinction of all these shells, — few in number, but singularly varied, — is a slender channel, thickened on each side, which

* I allude to the article regarding the *Strombidæ* in the second series of the *Zoological Illustrations*.

ascends from the aperture nearly to the top of the spire: the shell has much of the shape of a typical *Pleurotoma;* the basal channel being more or less lengthened. To this genus we are led by the *Strombidea tridentata,* — the only *Strombus* which gives us at once the outer lip of *Rostellaria curvirostris,* with all the other characters of our genus *Strombidea.* The first type of *Rostellaria* is seen in those elegant shells, *R. curvirostris* and *rectirostris,* where the siphon is moderate: the outer lip is hardly dilated, since its margin is merely divided into short processes. The *rectirostris* is of great rarity; but of still greater value is that which forms the second type; indeed, it seems to be known only by the figure of Chemnitz, and has been altogether omitted by Lamarck: it is channeled to the tip of the spire; while the outer lip, without being much dilated, is divided into a number of short spine-like processes. In the third type, *Rostellaria macroptera,* the upper siphon is equally long; but the lip, instead of being cleft, is entire, semicircular, and dilated to an enormous size. In these two last types, in fact, we have the greatest developement of the lip; and hence we may expect a declension in the succeeding forms. Such is accordingly seen in *Rostellaria columbata,* where the lip, although dilated and very broad, does not extend more than half way up the spire, although it is rather lengthened into the same sort of lobe as that in *Strombus pacificus.* There is still a great difference between *R. columbata* and the first type we noticed; but our fifth brings them together: this is formed of the small species, four or five in number, among which the elegant little Grignon fossil, *Rostellaria fissurella* Lam., is the best known. In these shells, the lip is no longer dilated, nor is it extended up the spire; they lose, in short, one half of the characters of their own genus, and in the same proportion assume those of *Strombus,* — thus becoming the most aberrant type of the sub-family; while their station between *R. curvirostris* and *columbata* is apparent to the most unscientific eye.

(131.) The last genus is that of Da Costa's *Apor-*

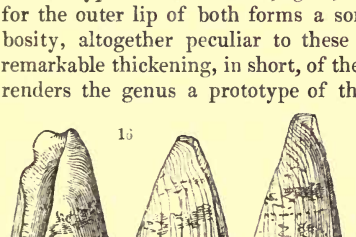
rhais, and the only example yet known is the *pes-pelicani,* or pelican's-foot strombus. That it has a close affinity to *Rostellaria columbata* is evident from the outer lip being dilated; but then it has four lobes, or rather flattened and digitated processes, something similar to *Pteroceras chiragra;* and it deserves attention, that these are the only two in the family which have the basal channel assuming precisely the form, size, and structure of the other processes of the outer lip: on the other hand, it has no distinct lobe at the base, its margin is not inflected, and the upper part advances upon the first spiral whorls;—in all which it shows an affinity to *Rostellaria.* In its young state, however, (*fig.* 15.*a*) it has quite a different appearance; for its form is then so much like that of a young *Cerithium* (*b*), that none but a scientific observer could detect the difference. Equally related in this manner to three different genera, we look upon this type as connected to *Rostellaria* on one side, *Pterocera* on another, and to the *Cerithinæ* on a third. All these affinities are more peculiarly apparent in its three different stages of growth; so that, when quite young, it is a *Cerithium;* when the outer lip is half expanded, it is a *Rostellaria;* and, in adult age. it puts on the very aspect of a *Pterocera.* Here we close our evidence on the affinities and natural arrangement of this family.

(132.) Having now gone through the *affinities,* we turn to the *analogies* of the *Strombinæ.* They are obviously the typical division of the whole family; and, as such, should represent within their own circle all the other divisions: this will be apparent in the following table:—

Analogies of the Genera of the STROMBINÆ.

Genera of STROMBINÆ.	*Analogies.*	Sub-families of the STROMBIDÆ.
Pterocera.	Outer lip greatly dilated, and lobed.	STROMBINÆ.
Strombus.	Outer lip detached above, and entire.	CONINÆ.
Strombidea.	Outer lip not detached, but gibbous; both lips thickened, and generally striated.	COLUMBELLINÆ.
Rostellaria.	Shell long, slender, fusiform.	PLEUROTOMINÆ.
Aporrhais.	Shell club-shaped when young; the channel very short, and twisted on one side.	CERITHINÆ.

These variations take place in precisely the same order as that in which the relations of affinity occur; for each of these columns is a circular group,—the genus *Aporrhais* being as much connected to *Pterocera* as to *Rostellaria*. Turning to the other group, we perceive the very same affinity between *Cerithium* and *Strombus*, through the medium of *Aporrhais*, as between *Cerithium* and *Pleurotoma*. The resemblance between *Strombidea* and the typical *Columbellinæ*, again, cannot be mistaken; for the outer lip of both forms a sort of angle or gibbosity, altogether peculiar to these two groups. This remarkable thickening, in short, of the lips in *Strombidea*, renders the genus a prototype of the *Columbellinæ*, as well as of the *Marginellinæ*. *Rostellaria* and the *Pleurotominæ* are the only fusiform groups in the whole family; while the likeness of a young *Aporrhais* to the *Cerithinæ* need not be dwelt upon. The resemblance between such shells as *Strombus Luhuanus* (*fig.* 16. *a*), when young (*b*), and *Conus amadis* (*c*), and others, is so great, that an unpractised eye can hardly tell the difference.



(133.) Our next comparison will be between the types of form in the genus *Pterocera*, and the genera of the *Strombinæ*.

Analogy of the Types of Form in the Genus PTEROCERA.

Types of PTEROCERA.	*Analogies.*	Genera of STROMBINÆ.
Lambis.	Basal canal greatly lengthened.	PTEROCERA.
Millipeda.	Basal canal short.	STROMBUS.
Sinuata.	Outer lip thickened, and inflected inwards; basal canal truncate.	STROMBIDEA.
Latissimus.	Outer lip extending to the apex of the spire, and entire.	ROSTELLARIA.
Chiragra.	Canal resembling the digitated processes of the lip, and turned on one side.	APORRHAIS.

In such small groups as these, we cannot expect the analogies to be very strong; a faint resemblance is all that exists—and all, indeed, that is necessary. Yet it is remarkable how perfectly *P. latissimus* corresponds to the *Rostellaria macroptera* in its excessively large outer lip, which, in both shells, runs up to the top, and even spreads far beyond the apex of the spire.

(134.) The analogies of the genus *Strombus* are numerous, and, in some measure, too complicated to be here introduced: it will be sufficient to remark, that, besides the five leading divisions or types of form, there may be discerned indications of another set of *secondary* types; so, that, if such groups were better understood (as no doubt they will be hereafter), some of them may be found to contain representations of the primary genera of the *Strombinæ*, no less than of its leading divisions. The time, however, is not yet come for such an elaborate study of analogies as this implies; and we shall, therefore, merely place before our readers the five divisions of the genus, which, as already specified, seem to be represented by the five following shells:—*Strombus Auris-Dianæ, gigas, lentiginosus, gibberulus,* and *succinctus*. All these are among the most common species,

and, as such, may be readily procured by every student who feels interested in these inquiries.

Analogies of Types of the Genus STROMBUS.

Species of *Strombus.*	*Analogies.*	Divisions of the *Strombinæ.*
S. Auris-Dianæ.	Channel bent; inner lip spreading on the spire.	APORRHAIS.
gigas.	Outer lip reflected, entire.	STROMBUS.
lentiginosus.	Outer lip inflected, divided above; basal lobe toothed.	PTEROCERA.
gibberulus.	Outer lip slightly or not at all expanded.	STROMBIDEA.
succinctus.	A long siphon running up the spire.	ROSTELLARIA.

By arranging the intermediate species between each of these types, the whole would exhibit another set of relations, as well as a series of connecting links; thus *Auris-Dianæ* is followed by a little group composed of *tricornis, gallus,* and *Peruvianus,* which connect the former shell with *S. gigas:* but the student, after these hints, will find no great difficulty in following up the theory himself.

(135.) The next genus, *Rostellaria,* is particularly interesting to the lover of analogies, inasmuch as all the types are not only existing, but are of that definite character which leaves no doubt of their true import.

Analogies of the ROSTELLARIÆ.

Species of *Rostellaria.*	*Analogies.*	Genera of *Strombinæ.*
Serrata Sw.*	Outer lip reaching to the tip of the spire, and divided into processes.	PTEROCERA.
Macroptera.	Outer lip very large, and entire.	STROMBUS.
Columbata.	Outer lip hardly attached to the spire, and dilated into a lobe.	APORRHAIS.
Rectirostris.	Outer lip not dilated at the top, and not extending on the spire.	STROMBIDEA.
Fissurella.	Outer lip hardly dilated, but the siphon ascending to the apex of the spire; the margin without teeth-like processes.	ROSTELLARIA.

* Figured in Chemnitz, pl. 195 A. fig. 1869.

It thus appears that each type of the *Rostellariæ*, as arranged according to their *affinities*, turns out to be a representation of one of the genera of the *Strombinæ*: and these analogies are so perfect, that it appears to us absolutely impossible they could be more complete — at least, in regard to the shells; although they would be even more beautiful, when accompanied by a corresponding relation in the animals. *R. rectirostris* is the fourth type, and not the common *curvirostris*; because this latter is intermediate in structure between the former and *R. fissurella*.

(136.) We feel persuaded, that if the concluding volumes of the elaborate work of Lamarck had not been finished "under the eyes of another," because their celebrated author had become blind, we never should have seen our *Rostellaria cancellata* and *canalis* placed in his genus *Strombus*. No species, in fact, either of *Strombus* or of *Pterocera*, so far as we know, occur in a fossil state. It appears hardly necessary, in so limited a group, to impose sub-generic names of these types; for if one is named, all should be so. Such designations are not necessary to facilitate research, when the whole genus contains not more than, perhaps, a dozen species. With the mitres, the cones, and the land snails, &c., the case is very different: such groups contain hundreds of species; and by designating their sub-genera under patronymic names, most material help is afforded, in all ways, to minute research, or to general views.

(137.) The connection of the Coninæ, or cones, with the *Strombinæ*, is effected by our new genus *Strombidea* in the latter, and *Terebellum* in the former. The affinities of these two genera we pointed out many years ago, by the publication of a shell which actually unites the characters of both *; and Lamarck entertains no doubt of the close connection of *Terebellum* to *Conus*. *Terebellum*, in short, merely represents the olives in this circle, without having any real affinity with them; but

* *Strombus dubius*. See Taylor's Phil. Mag. 61. No. 301. May, 1823. This will now be our *Strombidea dubia*. Specimens are in the rich collection of Mr. Stanford.

of their animals, nothing, we believe, is yet known. The true cones, from their beauty, are the favourite shells of conchologists. Nearly all are natives of tropical climates, where they constitute one of the most extensive races of the carnivorous shell-fish. The mouth is a short proboscis (*fig.* 16. *a*), which in one genus (*Coronaxis* Sw.) has the margin simply circular, while in the other (*Conus* Linn.) it is laciniated, or divided into a circular fringe of little points, analogous to the lips of the *Trochidæ*. In both these genera, the tentacula (*b*) are short, cylindrical, and nearly obtuse, with the eyes small, and but slightly developed, placed half way on their external side: the foot is small, rather broad, truncate in front, and rounded behind, where it bears a small oblong operculum, sufficient only to close the detached part of the top of the outer lip. The respiratory siphon (*c*) is well developed, but its form seems to vary in the sub-genera: in some, it is thickest at the base (as in *C. bandanus**); in others (*C. arenatus*), it is uniformly cylindrical.† Lamarck describes no less than 181 species, besides nine fossil; but we question if there are not more than 230, or perhaps 250, species already in collections. Such an immense assemblage of mere species, as they now stand, fully justifies us in giving patronymic names to the sub-genera, and arranging them in distinct groups; a plan long ago recommended ‡, but never yet acted upon. By separating the coronated from the smooth species, nothing material is gained; for although they constitute, in reality, two genera, the internal relations subsisting between them are passed over; and these, in our opinion,

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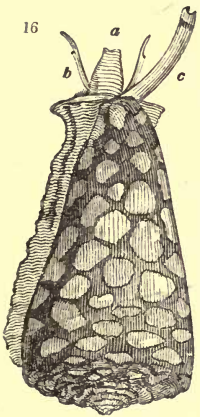


* Voy. d'Astrolabe, pl. 52. fig. 7., here copied *fig.* 16.
† Ibid. pl. 52. fig. 8. ‡ Sow. Genera of Shells, article *Conus*.

are the most important object to be illustrated; while the mere collector has no additional help to the nomenclature of the species, more than he now has. Long and procrastinated attention to these beautiful shells, together with the invaluable delineations of their animals by M. Quoy, has now enabled us to give the following exposition of the genera and sub-genera.*

Analogies and Characters of the Sub-genera of CONUS *and* CORONAXIS.

CONUS. Types of the Sub-genera. *Shell not coronated.*	*Characters of each.*	CORONAXIS. Types of the Sub-genera. *Shell coronated.*
C. litteratus. virgo. generales.	Shell ponderous; basal whorl not contracted near the suture; spire in general flattened.	*Bandanus* marmoreus.
striatus. stercus-muscarum. ammeralis.	Shell ponderous; basal whorl contracted near the suture; spire short, pointed.	*Arenatus* cedo-nulli.
bullata. textile. auratus. aulicus.	Shell light; basal whorl ventricose; aperture effuse; the base hardly notched; spire short, pointed, concave.	*Tulipa.*
nussatella. glans. terebra.	Shell sub-conic, cylindrical, transversely grooved; spire elevated, thick, convex, generally obtuse.	*Asper?*
amadis. grandis. duplicatus. australis.	Shell conic, light, often transversely striated; spire concave, elevated, and pointed; outer lip deeply sinuated above.	*Antediluvianum.*

This, perhaps, is one of the most remarkable instances of analogy yet brought before the reader; inasmuch as the characters used as analogies are those only by which the shells of each group, or sub-genus, of *Conus* and *Coronaxis*, can be defined. Nothing additional, in fact, can be added to separate, for instance, the sub-genus of *Conus*, whose type is *C. litteratus*, from its representative, *C. marmoratus*, in the genus *Coronaxis*: so perfect are these resemblances, that we do not actually know where the two groups join and unite. As to the circularity of each, there cannot, we apprehend, be the least doubt; for the intervening shades of difference are so gentle, that we hardly know where one type ends,

* The names of the types are in *Italic*; those of the annectant species in Roman.

and the next begins.* Such only are natural and perfect groups: they are the delight of the philosophic naturalist, and the torment of the mere nomenclator. As *Conus* is the most numerous in species, so it is the most perfect in these gradations, by which its five sub-genera are blended into one circle. The superior heaviness which belongs to the two typical divisions in each, is very singular, and may, probably, be owing to the internal volutions of their shells not being so much absorbed as in the other types: a simple section, however, will, no doubt, explain the cause.

(138.) Whether *Conus dormitor*, and other fossil species, really constitute the analogous genus in this circle to the *Pleurotomæ*, cannot be determined, as no recent species, that we know of, have been discovered: we shall, however, regard them in this light under the generic name of *Conorbis*. The only remaining genus is that of *Conella*, hitherto overlooked among the diversified shells placed in *Columbella* by Lamarck, where they continue to the present day. They are all very small, and perfectly resemble Cones in their shape; but they may be easily known by the outer lip, which advances upwards on the spire, and is marked internally by distinct elevated striæ. This is a most interesting group; for it not only connects this and the succeeding sub-family of *Columbellinæ* in the most satisfactory manner, but, at the same time, it preserves an affinity, on the other hand, to *Conorbis*.

(139.) The CONINÆ, thus arranged, form themselves into the five following genera, analogous to the primary divisions of the *Strombidæ*. The genus *Conella* (*fig.* 17. *a.*) connects this and the last sub-family.

* There is one rule, however, which we have found quite sufficient for this purpose. If, of three characters of a given type, a species possesses only one, and that but slightly developed, the probability is, that it really belongs to the next type; or the question may be decided by the law of representation. Every natural and perfect group, of whatsoever value, contains representations of all the other four groups of its own value in that circle which unites them all. Thus, it will not be difficult for the naturalist to discover, in that sub-genus which includes *Conus striatus*, representations (among the species) of all the other four.

Analogies of the Coninæ, *or Cones.*

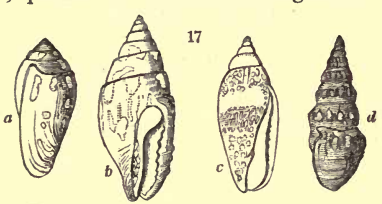
Genera of the Coninæ.	*Analogies.*	Sub-families of Strombinæ.
Conus.	Spire short, smooth. Typical.	Coninæ.
Coronaxis.	Spire coronated or nodulous.	Strombinæ.
Terebellum.	?	Cerithinæ.
Conorbis.	A deep sinus or cleft at the top of the outer lip.	Pleurotominæ.
Conella.	Outer lip striated internally.	Columbellinæ.

The third analogy, not being apparent in the shells, probably may be traced in the animals. But this is not very material, since the whole arrangement is founded upon affinities, and all the other analogies are perfect.

(140.) The Columbellinæ, or dove-shells, although of a small size, rather smooth, and without any dilation of the outer lip, have, nevertheless, very much the aspect of little wing-shells; this impression originates in the thickened angle or hump on the upper part of the outer lip; a character which is seen in no other group but that of *Strombidea*, and in certain *Marginellæ*, — both which, in fact, are legitimate representatives of *Columbella*. According to Guilding, the animals of this group, like that of *Conus*, have the operculum so very small as often to escape detection.

(141.) The result of an attentive analysis leads us to arrange the whole of these shells under the five following genera: — 1. We retain the name of *Columbella* to the *C. mercatoria*, and the other European species, where the crenated teeth of the reflected inner lip extend its whole length, and are regularly graduated, those on the inner being but slightly developed. 2. In *Pusiostoma*, the teeth on both sides of the aperture are much more developed; those on the outer lip are crowded, very thick, and only occupy the *middle* portion. Both these, but particularly the last genus, have the top of the lip so gibbous, as to form a prominent and even projecting angle: they constitute the sub-typical and the typical groups, and consequently exhibit the

characters of the *Columbellinæ* in the highest perfection. The three aberrant genera are more diversified. Thus, *Conidea* (*fig.* 17. *b*) has the general form of a short fusiform mitre (like *Mitra contracta**), or that of a cone with the spire as long, or longer, than the body-whorl, but still with the volutions thickened at the suture, and the aperture narrow: there are a few tooth-like striæ on the inner part of the outer lip; but it is not thickened in the middle: the inner lip forms an elevated ridge at the base; parallel to which is a longitudinal elevated



fold slightly crenated; but the tuberculated teeth on the pillar are entirely wanting. In some species the spire is rather lengthened, with the aperture widened: and this change brings us to the 4th genus, *Nitidella* (*c*), where the inner lip and its fold totally disappear; the upper part of the pillar, or rather that side of the whorl which forms the aperture, is flattened, as if pared down artificially (as in *Purpura*); the base is finely striated, as in *Ancillaria*, and is terminated by a distinct plait (sometimes two), such as is seen in *Volutilithes*. All these resemblances point to one type of structure, and intimate this to be the most aberrant sub-genus of the *Columbellinæ*. There are many species, but all small; the most common of which is the *Columbella nitida* of Lamarck†, a little West Indian shell, in almost every collection: the outer lip is either smooth or slightly striated within; but although the edge is slightly thickened, it is never contracted in the middle — nor is the margin, although inclining inwards, decidedly

* Zool. Ill. 1st Series. † *Nitidella marmorata*. Sw. (*fig.* 17. *c.*)

inflected: hence these shells, on a cursory glance, much more resemble the *Buccininæ* than the *Columbellinæ:* they are almost always smooth, and generally shining. The 5th and last genus is *Crassispira.* (*fig.* 17. *d.*) These are also small shells, having the outer lip, externally, almost as thick as in *Pusiostoma,* but with a distinct notch at the top; this notch is in the same position, but not near so deep, as in the club-shaped *Pleurotominæ:* like them, also, the spire is rather long, and the base very short; so that at first sight they remind us of very small *Cerithinæ:* the aperture is contracted both above and below, but wide in the middle; thus being precisely the reverse to that of *Pusiostoma,* which is contracted in the middle, and wider at the extremities. These shells, of which there are several species, are known at once from the *Pleurotominæ,* to which, however, they lead, by the outer lip being inflexed and much thickened, and by the sinus not extending beyond the margin. In such species as unite with *Pusiostoma,* the aperture is slightly toothed, and much contracted; while in those, on the other hand, which pass into *Nitidella,* the shell is more fusiform, the mouth more effuse, and the outer lip thin. These variations, which would otherwise be unaccountable, are fully explained by the relations that this singular little genus bears to the two adjoining groups of the *Columbellinæ,* and render it one of the most natural in the whole family.

Analogies of the GENERA *of the* COLUMBELLINÆ.

Genera of the *Columbellinæ.*	*Analogies.*	Typical Genera of the *Strombidæ.*
Columbella.	Sub-typical; shell coniform.	CONUS.
Pusiostoma.	Typical; shell strombiform; outer lip very prominent.	STROMBUS.
Crassispira.	Shell tuberculated, club-shaped; aperture widest in the middle.	CERITHIUM.
Nitidella.	The outer lip often forming a sinus at the upper part; aperture effuse.	PLEUROTOMA.
Conidea.	Aperture very narrow; whorls thickened at their suture.	MARGINELLA.

This table is drawn up for the especial purpose of

explaining the singular mixture of characters concentrated in this sub-family; for the only one by which all its genera are bound together, consists in the outer lip being invariably inflexed, and either striated or toothed. Some of the analogies are weak, others strong; but as they follow each other in the same series as that of the primary divisions of the family, this regularity, of itself, is quite sufficient for our purpose. The singular tuberculated tooth at the bottom of the aperture, in several of the *Nitidellæ*, their flattened pillar terminated by an internal fold, the absence of a definite inner lip, and the effuseness of the aperture, are all explained, by the following table.

Analogies of the Genera of the COLUMBELLINÆ.

Genera of the COLUMBELLINÆ.	*Analogies.*	Sub-families of the VOLUTINÆ.	Genera of the VOLUTINÆ.	Sub-families of the MURICIDÆ.
Columbella.	Sub-typical.	MITRA.	CYMBIOLA.	MURICINÆ.
Pusiostoma.	Typical.	VOLUTA.	VOLUTA.	CASSINÆ.
Crassispira.	Outer lip much thickened, and notched above.	MARGINELLA.	SCAPHELLA.	BUCCININÆ.
Nitidella.	Obsolete plaits at the base of the pillar; aperture effuse, sometimes with an internal tooth.	ANCILLARIA.	VOLUTILITHES.	PURPURINÆ.
Conidea.	Spire short; inner lip much developed.	OLIVA.	HARPULA.	NASSINÆ.

(142.) But the *Columbellinæ* possess other resemblances, among which that to the mitres has been thought so strong, as to induce the early reformers of conchology to place them both in the same genus; hence it was taken as a resemblance of affinity. We have seen, however, by the analysis of the *Volutidæ*, that this idea is erroneous. The impression undoubtedly originated in the strong resemblance between the strombiform division of the mitres, forming our genus *Harpella*, and the typical *Columbellæ*. Yet even this, although a striking instance of relationship, is only analogical, as will be seen more clearly by the following table:—

Analogies of the STROMBIDÆ *and the* MITRINÆ.

Families of the STROMBIDÆ.	*Analogical Characters.*	Genera of the MITRINÆ.
STROMBUS.	Shell generally rugged.	*Tiara.*
CONUS.	Shell smooth, destitute of protuberances on the body whorl.	*Mitra.*
COLUMBELLA.	Outer lip very much thickened, inflexed, and crenated.	*Harpella.*
PLEUROTOMA.	Often coniform; tip of the outer lip sinuated.	*Conœhelix.*
CERITHIUM.	?	*Mitrella.*

(143.) Without going further into particulars, we may observe that these tables afford strong collateral evidence that the strombiform structure — at least, in this order — is one of the PRIMARY TYPES of form, which is repeated and represented, under every possible modification, in almost all the groups hitherto noticed.

(144.) The PLEUROTOMINÆ is our next sub-family. The perfect gradation of forms which connects this remarkable group with the cones, will, it is presumed, remove all doubts as to its supposed affinity with the *Fusinæ*. Nothing, indeed, short of the evidence here adduced would have satisfied us that Lamarck was in error in approximating *Pleurotoma* to *Fusus:* so strong are early impressions and preconceived opinions. The discovery, however, of the genus *Crassispira* brings into this group, by means of the new genus *Brachytoma*, a small group of shells, having the aspect of some Lamarckian *Fusinæ*, but with the basal canal longer, and the spire shorter, than *Crassispira*. One of the most typical has been aptly named *Strombiformis*;* it is turreted and nodulous, with the notch at the top of the outer lip short, and nearly semicircular, — hardly more developed, in fact, than it is in *Crassispira*. There are several other species, mostly nodulous, and having the general appearance of such shells as *Fusus Syracusensis*. We next come to the typical genus *Pleurotoma*, where the channel is so much lengthened as to be little shorter than the spire. These appear to be succeeded by a group

* Sow. Manual, fig. 381.

to which we have retained Lamarck's original name of *Clavatula;* it has the long narrow slit of *Pleurotoma*, but with a very short canal. Following this comes *Clavicantha*, having the canal equally short; but the *sinus*, or notch, instead of being linear and long, is short and wide, the surface is rough, and the whorls either coronated with prickles or with compressed nodules resembling spines. The last genus is *Tomella*, which has the spire and canal nearly equally fusiform; but the former is of very few whorls, and the inner lip is considerably thickened within, where it joins the outer lip. In these five genera, all the varied species of this group will arrange themselves: the two typical are recognised by the length and narrowness of the sinus, which, in the three aberrant genera, is short and wide. *Clavicantha* is a very remarkable form, inasmuch as it seems probable that *echinata* and *auriculifera** are fluviatile shells. Lamarck describes them as *Pleurotomæ;* and not having seen them, we take his authority for the fact; but we might almost question whether they do not belong to *Potomis*, which is the first genus in the *Cerithinæ*,— so intimately do these sub-families appear connected. Nearly the whole of these shells, like the mitres, are scarce; and yet the species are numerous. They chiefly come from the Indian seas, and other warm latitudes.

(145.) The situation and the genera of the *Pleurotominæ*, thus determined by analysis, offer some very curious analogies which merit our special notice. The sinus, which gives them the appearance of having the outer lip dilated, although it is really not so, is only a modification, as we believe, of the wider sinus nearly in the same part of the outer lip in *Strombus;* and these, again, are but different modifications of the same part in the typical cowries, where the outer lip forms a sinus before it joins the umbilicus or depression of the spire. That this fissure is intended to admit the protrusion of some particular organ of the animal, is un-

* Ency. Méth. pl. 439. figs. 8. 10.

questionable; but, until we know what the structure of this animal really is, nothing further can be determined. A similar notch is found in the genera *Ianthina*, *Scicurella*, and *Pleurotomaria*, among the phytophagous families; and the slit, in certain *Emarginulæ*, may probably be analogous. By disposing the genera in the order they have here been placed, some interesting analogies will come to light.

Analogies of the PLEUROTOMINÆ *and the* STROMBIDÆ.

Genera of the PLEUROTOMINÆ.	*Analogical Characters.*	Genera of the STROMBIDÆ.
BRACHITOMA.	Outer lip gibbous and ascending; inner generally thickened.	STROMBIDEA.
PLEUROTOMA.	Typical; canal considerably lengthened, as long as the spire.	PTEROCERA.
CLAVATULA.	Sub-typical; canal short.	STROMBUS.
CLAVICANTHA.	Canal very slight.	APORRHAIS.
TOMELLA.	Inner lip considerably thickened.	ROSTELLARIA.

(146.) We now turn to the CERITHINÆ, or club-shells, the last division of the family. They merit this name, not merely from their shape, but from having the whorls encircled, either with obtuse spines, nodules, or granulations. To M. Quoy we are indebted for a knowledge of the animals of three of the genera, each of which has some marked and peculiar character,—more so, even, than their shells. Hitherto, with the exception of *Potomis* and *Pirena*, they have been placed in one genus. These two, from being covered with a strong epidermis, are presumed to be fluviatile, or, at least, living in the estuaries of rivers; the rest are found in marine but generally shallow depths, and often in pools left by the tide. The species are numerous, both in a recent and fossil state, particularly in the newest formations, where some are stated to occur precisely similar to those now living. The whole of these shells have a very long spire, a small body-whorl, and the outer lip considerably dilated. The first genus is Brongniart's *Potomis*, which may be called the coronated type, being encircled with obtuse spines and granulated points;

the basal canal is scarcely developed, so that it merely forms a sinus; the epidermis is strong, and of a rich fulvous brown, beneath which the shell is white. The typical genus *Cerithium* appears to follow next, chiefly distinguished by its short and nearly straight canal: the operculum is oblong and ear-shaped, and the pillar smooth. These almost insensibly glide into *Rhinoclavis*—well distinguished, however, by the shell having a distinct plait on the pillar; the basal canal fully developed, and turned backwards; and by the operculum being perfectly circular. These are very elegantly marked shells: the colour is generally white; and the surface is often reticulated into little asperities, something like those on a file. To these succeed *Terebralia*, generally of a black colour (as representing the *Melanianæ*), of a large size, and having the outer lip so much developed, that in almost all, when fully grown, it actually joins the other, and leaves only a circular opening for the respiratory siphon of the animal: this siphon, as shown in the admirable figures of M. Quoy, assumes the shape of a radiated star, which occupies the perforation, but does not protrude beyond it: the tentacula are very long; and here, for the first time, we begin to see the commencement of that high developement of the eyes, for which the next groups, or the *Pteroceræ* and the *Strombi*, are so much distinguished: the operculum, as in *Rhinoclavis*, is round; but there is no plait upon the pillar, and the basal canal hardly projects. The genus *Pirena* * completes the circle, by showing us a truncated based *Cerithium*, with the sinus of a *Pleurotoma*. These shells, like *Potomis*, are fluviatile; and thus we return to the point from whence we began: the variations, however, are so few, that the analogies are not striking.

(147.) That the *Cerithinæ* pass into the *Strombinæ*, by means of *Aporrhais*, we have, individually, no doubt: we ground this belief more upon the similarity

* Férussac has most unaccountably joined this very beautiful and distinct type with *Melanopsis*.

of their animals, than of their shells; and yet, when we look to the young shells of *Aporrhais*, and of certain *Terebraliæ*, they might very readily be placed in the same genus: the cuts (*fig.* 15.) already given at p. 142. will bring this fact more prominently before the reader. We are not so confident, however, in regard to the absolute affinities of certain species of *Potomis*, which have the aperture oval, and the basal channel almost obliterated: they may, indeed, be the connecting links between *Pol. muricata* and the genus *Clavicantha*; but until Lamarck's *Pleurotoma echinata* and *auriculifera* are better known, some doubt must hang over them: on the other hand, this is the point of union between the two great tribes of the *Zoophaga* and the *Phytophaga*; so that the very first genus which we should have to notice, if we followed the thread of affinity in this direction, would be that of *Melania*, in the family of the *Turbidæ*,—being precisely that to which these aberrant species of *Potomis*, with an oval aperture, would seem to belong.

CHAP. VI.

ON THE PHYTOPHAGOUS TRIBE OF SHELL-FISH.—THE PRIMARY DIVISIONS OR FAMILIES.—THE HELICIDÆ, OR LAND AND FRESH-WATER SNAILS.

(148.) THE second great tribe of the gastropod shell-fish is that to which, after the illustrious Lamarck, we apply the name of *Phytophaga*, since they not only subsist upon animal, but also vegetable, substances: they are easily known from the truly carnivorous tribe, by being destitute of the respiratory siphon, and in the mouth not being retractile, or proboscidiform. In regard to the shells, the differences are equally well defined. From the absence of the respiratory tube, the aperture is round and entire, or at most is only slightly notched in such genera as unite the two groups. The

whole are regular spiral shells,—a character by which they are separated from the *Scutibranchia,* or limpets. The great majority are external shells, and all but one small group—the slugs and their representatives,—have their habitation sufficiently large to contain the entire body. Their modes of breathing and propagation are various, and greatly diversified even in genera close to each other; so that nothing can yet be determined of a general nature on these points. Although the greater part of the *Helicidæ,* or snails, live upon land, and therefore breathe differently, a portion of the same family live in fresh water; and even some of the slugs appear to be found only on the sea shore: the rest of the tribe, excepting the *Melanianæ,* are all marine.

(149.) The secondary divisions or families are first distinguished by the formation of their animals, and secondly, by the nature of the shells: this latter mode, however, will lead to great confusion, if not regulated by the former; since there are many genera in different families, whose shells are nearly of the same form, although inhabited by very different mollusks. As this will become evident when we enter into their details, we shall at once characterise the chief divisions. The first, or the most typical, are the *Helicidæ,* which includes the testaceous land snails, the naked slugs, and the pulmonary fluviatile shells.* The second, or *Trochidæ,* are entirely marine: the shell is almost always perlaceous; the body of the animal is furnished with lateral filaments, and its mouth with lips, as in the last; and the shells of both are turbinated and spiral. The third, or *Haliotidæ,* are known by their flat ear-shaped shells, having only the rudiment of a spire, and without any pillar: hence they may be even called spiral limpets. The fourth is the *Naticidæ,* or nerits, where the spire also is very small, but the pillar is always thick; the exposed part, or inner lip, often very broad; and the animal slug-shaped. The fifth, or

* This group corresponds, with a few trifling exceptions, to the *Pulmonaria* of the *Règne Animal*..

Turbidæ, can only be characterised effectually by their animals: they bear a close resemblance, in their eyes, tentacula, and mouth, to the *Zoophaga*, and several of the genera, as *Turbo*, *Ampullaria*, &c., are provided with the same sort of siphon: the shells themselves are all more or less spiral, and exhibit some of the most elongated forms in the whole tribe.

(150.) The slight degree of analogy between the families of this tribe and the zoophagous *Gasteropoda* will, no doubt, be strengthened hereafter, when the animals of each are better understood.

Analogies of the PHYTOPHAGOUS *and* ZOOPHAGOUS GASTEROPODA.

Families of the *Phytophaga*.	*Analogical Characters.*	Families of the *Zoophaga*.
HELICIDÆ.	Typical.	MURICIDÆ.
TROCHIDÆ.	Sub-typical.	TURBINELLIDÆ.
HALIOTIDÆ.	Foot enormously large; tentacula very short; spire of the shell very small.	VOLUTIDÆ.
NATICIDÆ.	Shell highly polished, partly or entirely covered by the animal.	CYPRÆIDÆ.
TURBIDÆ.	Animal carnivorous; mouth proboscifform, with a respiratory siphon.	STROMBIDÆ.

Without dwelling upon these points, therefore, we shall take a detailed survey of each of the families.

(151.) The HELICIDÆ is one of the most remarkable families in the whole order of the *Gasteropoda*, in as much as it is the only one of the truly testaceous divisions, wherein we find mollusks entirely naked closely and intimately united to others which have perfectly formed shells. To separate the naked slugs from such as begin to have the rudiments of a shell, and these latter, again, from others, like the garden-snails, whose habitation is sufficiently large to contain them, would be such a violation of nature as no writer has yet attempted; we must, therefore, include them in the same family. We may account for this apparent anomaly, by supposing that, as this is the pre-eminent type of the phytophagous *Gasteropoda*, nature, so to speak, has, more

distinctly than in any others, pointed out the mode which she pursues in the development of all her groups. Commencing from the most simple form, she gives us the first germ of the limaciform structure in the extraordinary genus *Herpa*, hereafter noticed. From this point, as it were, she makes two diverging series; the one to the right hand, through the terrestrial slugs; the other to the left, through the semi-aquatic slugs and the freshwater snails: and these two series, after passing through numerous links, finally meet in the pupaceous-formed shells, constituting the genera of *Pupa* and *Clausilia*. It is by this theory we account for the actual presence of naked mollusks among the *Helicidæ;* and in this manner do we consider that the whole form a circular group, the particulars of which will be more clearly stated hereafter.

(152.) The HELICIDÆ are the only animals of the *Testacea* which breathe atmospheric air. From this circumstance they have been considered, by some, in the light of a distinct order; but their close and intimate connection with the *Turbidæ* on one hand, and even with the *Trochidæ* on the other, clearly shows their situation to be intermediate, and that they, therefore, only constitute a family group. The respiratory organs of these animals simply consist of a moderate-sized oval aperture, placed under the reflected edge of the mantle, which can be dilated or contracted at pleasure; hence there are no branchia, but merely, according to Cuvier, "a network of pulmonary vessels, which spread over the parietes and pulmonary cavity." The number of tentacula is variable, according to the different groups; but they are usually four,—two long and two very short; the former bear the eyes at their extremities, but these organs are only so far developed as to appear like black points. So far as we yet know, the greatest uniformity pervades the animals of all the *Helicinæ*, or turbinated land-snails, so that the minor divisions rest entirely on the structure of their shells; but in the spiral snails (or the sub-family *Achatinæ*)

both the animals and the shells are more diversified. Hence, while scarcely any thing has yet been done in determining the genera and sub-genera of the *Helicinæ*, nearly all those of the *Achatinæ* have been named and defined. It is time, however, to quit these general remarks, and proceed to the sub-divisions of the family.

(153.) We arrange the whole of this group under the five following families, which may be thus defined:—1. the *Helicinæ*, or testaceous snails, having perfect turbinated shells more or less depressed; the aperture entire, but without teeth. 2. The *Achatinæ*, or spiral snails, the spire of whose shells is elongated and conic. 3. The *Limnacinæ*, or river-snails, having only two depressed or flattened tentacula, and no operculum. 4. the *Limacinæ*, or slugs, having either no shell, or one much too small to contain the body. And 5. the *Lucerninæ*, or terrestrial volutes, where the shell is orbicular, depressed, or flattened, and the aperture furnished with distinct teeth.* That the foregoing series is probably the natural one, may be inferred from the following table of analogies:—

Analogies of the HELICIDÆ.

Sub-families of *Helicidæ*.	*Analogical Characters.*	Families of the *Phytophaga*.	Families of the *Zoophaga*.
HELICINÆ.	Spire most generally with the whorls depressed.	HELICIDÆ.	TURBINELLIDÆ.
ACHATINÆ.	Spire mostly produced.	TROCHIDÆ.	MURICIDÆ.
LIMNACINÆ.	Outer lip considerably dilated.	TURBIDÆ.	STROMBIDÆ.
LIMACINÆ.	Animal much larger than its shell, the sides of which, where it exists, are enveloped in its mantle.	NATICIDÆ.	CYPRÆIDÆ.
LUCERNINÆ.	Depressed, or the spire very small; aperture furnished with plaits.	HALIOTIDÆ.	VOLUTIDÆ.

These analogies are, of course, only applicable to the types of each, and are intended to be so understood:

* The injustice of the attempt made by M. de Férussac to substitute a new and artificial nomenclature of his own for the *Helicidæ*, and so to cancel the previous generic names of Lamarck, Draparnaud, and of all his predecessors, is without parallel in this or perhaps any department of zoology, and can only be equalled by the confusion it has caused.

we have stated them merely as a preliminary step, to show the general, not the particular, resemblance of the primary groups. The extreme difficulty attending such an analysis of the *Helicinæ* and the *Lucerninæ*, as is necessary to determine the sub-generic types, will prevent us, for the present, from entering into the details of these two groups so fully as we shall do in regard to the others. We commence with the HELICINÆ, as the most typical group; but, from the above cause, its analysis will be less minute than that of the other divisions.

(154.) The typical sub-family of HELICINÆ, although more numerous, perhaps, than any of the land-shells, has received less attention, in regard to its natural divisions, than any group of the same rank. This has probably originated in two causes; the entire similitude that runs through the animals, and the little variation, of a decided and very prominent nature, observable in the shells. Nevertheless, a closer attention leads to the belief that this group, within itself, will be found as diversified in its modifications as any, — less obtrusive, indeed, but promising the same results, when thoroughly analysed, as in all natural groups. As a whole they are immediately known from the *Lucerninæ*, or land-volutes, by never exhibiting a discoid shell furnished with plaits or teeth: the aperture of one division, indeed (*Pupa*), has these appendages; but then the form of all the shells is spiral and elongated, and cannot therefore be confounded with the *Lucerninæ*. The *Helicidæ*, perhaps, are best distinguished by the aperture being without teeth and transversely oval, — a shape which results from the depressed form of the body-whorl, which, in the *Achatinæ*, is always oblong; and this character is the more important, because it is preserved even in such genera as *Geotrochus*, whose spire is often as conical and as much produced as that of the *Bulimi*. It is also to be observed that, with very few exceptions, these half-spiral snails have the tips of the spires very obtuse and even flattened; whereas, in the *Achatinæ*, they are always pointed

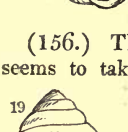
and comparatively slender. Our analysis of the *Helicinæ* not having been yet completed, we are only acquainted with the four following genera; the fifth, which should intervene between *Helicella* and *Pupa*, being yet undetermined. In the first, or *Helix* proper, we have the great proportion of shells usually so called, of which the *Helix hortensis* is a good example; they are strictly turbinated shells, the spire being very slightly elevated; the body-whorl ventricose; the aperture without teeth; and the base of the pillar never separated from the outer lip: this is the typical genus. The second, or sub-typical, is *Geotrochus*, where the spire is always elevated, and composed of more than four whorls *, generally of five, and sometimes of six: the typical species are trochiform; but the sub-genus *Pithohelix* puts on the aspect of a *Bulimus* or *Achatina*. The third is *Pupa*, where the spire reaches its full development, and the aperture becomes nearly circular: by this character *Pupa* may be readily distinguished from *Clausilia* and all its subordinate types. Our fourth genus is composed of the remaining portion of Férussac's *Helicellæ*, typically represented by those disk-like shells which are destitute of a pillar; the spire very short, and often sunk below the level of the margins (as in *Planorbis*); the body-whorl ventricose; and the outer lip considerably thickened: this group has no indications whatever of the incipient teeth seen in *Hemiodon*, and yet it connects the land-volutes and the present sub-family of *Helicinæ* in the most perfect manner. We shall not in this place offer any conjectures regarding the fifth type, but proceed at once to give our analysis of the two typical genera, *Helix* and *Geotrochus*, so far as it has yet extended.

(155.) The sub-genera of HELIX appear to us to be as follows: — The first, on leaving *Helicella*, is *Hemicycla*, distinguished from *Helix* proper by the broad and flattened margin of its outer lip, and by the absence of the inner, except occasionally a little tubercle, sufficient to point out its analogy to the *Lucerninæ;* but there

* The last, or body-whorl, being excluded.

are never any on the outer lip. In the second, or *Helix* proper, the spire is more elevated, the shell more globose, the umbilicus covered, and the outer lip more or less reflected: these obviously lead to *Zonites*, which chiefly differs in the outer lip being always thin, the spire more depressed, and the umbilicus more or less open. By degrees, however, the spire becomes more and more elevated, until, in that singular shell *Epistylia conica** (*fig.* 18. *a*), we have a *Pupa* and a *Helix* combined in one form. The last is a very beautiful type, already characterised as a sub-genus by Mr. Gray, under the appropriate name of *Strepsaxis*, while its obvious affinity to *Hemicycla* brings us again to the point whence we commenced.

(156.) The genus GEOTROCHUS, in like manner, seems to take the following course, corresponding to that of *Helix*. We give the name of *Hemitrochus* to certain trochiform shells, (*fig.* 19.), having the spire nearly as elevated as in *Epistylia*, but less thick; the whorls much fewer, and the inner lip margined internally; the basal whorl is not angulated, so that, if the spire were not conic, and the inner lip not thickened within, they might be arranged with *Zonites*. These shells at once bring us to the typical sub-genus *Geotrochus* proper, where the body-whorl in its widest circumference is more or less carinated, and the spire gradually tapering to a pointed cone; it is, in fact, just the shape seen in the marine Trochuses: in some few species, chiefly small and European, the margin of the lip is thin, but in the more typical ones from tropical America it is thickened, dilated, and almost reflected. Our next sub-genus, *Pithohelix* is as spiral as the last; the spire, however, is obtuse at the top, the body whorl not angulated, and the aperture, consequently, rather higher than broad: such as have the spire



* *Helix epistylium* of authors.

more than usually produced, resemble *Bulimi*, but with this difference, that the whorls are more ventricose and the top of the spire more obtuse; in some the base of the pillar forms a small sinus or notch before it joins the thickened outer lip, analogous to the *Achatinæ*; but in that the margin is always thin, and the spire more contracted and pointed: something of this form belongs to our next sub-genus *Geomitra* (*fig.* 20.),

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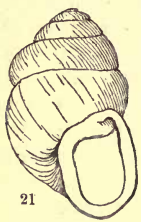
founded upon a most extraordinary little shell discovered by Mr. Lowe in Madeira, and exhibiting the only instance of coronated nodules on the whorls we are acquainted with in this family. The form is that of the last type; but the mouth is thin and completely circular, like that of a *Pupa*, to which genus we consider it leads. As connecting *Geomitra* with *Hemitrochus*, we here place the fifth sub-genus *Gonidomus* (*fig.* 21.), which, in the distortion of its whorls, is a complete prototype of *Strepsaxis*. The genera HELIX and GEOTROCHUS would thus appear to form two circles, whose subordinate types may be thus stated.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Analogies of the Genera HELIX *and* GEOTROCHUS.

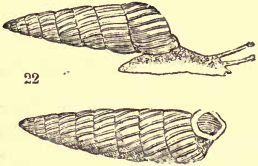
Sub-genera of HELIX.	*Analogical Characters.*	Sub-genera of GEOTROCHUS.
Helix.	Body-whorl large, ventricose; umbilicus none.	*Pithohelix.*
Zonites.	Body-whorl depressed, narrow; umbilicus open.	*Geotrochus.*
Epistylia.	Spire elevated, obtuse; body-whorl depressed, the margins convex.	*Hemitrochus.*
Strepsaxis.	Spire and whorls distorted.	*Gonidomus.*
Hemicycla.	Aperture or outer lip perfectly round.	*Geomitra.*

These sub-genera agree sufficiently well to render any additional illustration unnecessary. We shall therefore

at once proceed to the genus *Pupa*, the passage to which has been opened by *Geomitra*.

(157.) The genus PUPA we shall restrict to those maggot-shaped cylindrical shells whose body-whorl is larger than the others, whose spire is thickened in the middle, and which have no teeth on the inner lip; the aperture also, in three out of the five sub-genera, is always round, but in the two others it is oval, on account of their blending into the genus *Clausilia*. Having analysed both these remarkable genera, we feel much more confidence in stating the types than in what has been said regarding those of *Helix* and *Geotrochus*. The type of this present group is that extraordinary and rare shell the *Megaspira* of Lea, of which a noble specimen, containing no less than twenty-two whorls, is in our cabinet. The outer lip is thin, and the inner wanting; but there are four sharp plates close together at the base of the pillar, and a central one on the inner side of the body-whorl: it must be remarked that this shell, although of such excessive length, does not lose the apex of its spire, which is obtuse almost to its very tip: this is an important character, because it is carried on to our sub-genus *Gonospira*, where this part is the same, but even more obtuse: the volutions, however, are only seven, yet the shell has the same form as the last, so that the spiral whorls are nearly of equal thickness; the aperture is more that of *Pupa*, being oval; it is thickened all round, and there is a tooth at the upper angles. This leads at once to the sub-genus of *Pupa* proper, distinguished from both the foregoing by the suddenly-pointed shape of the apex, and the increased thickness of the two lips, which, as in *Gonospira*, are united: all the typical species in like manner have a tooth; but this disappears in such species as pass into *Plicadomus*, where the inner lip is entirely wanting, the aperture having a dilated margin, and perfectly entire, while the apex of the spire, no longer suddenly contracted, is obtuse: it is by this sub-genus, as we think, that the whole group is united to *Geomitra*; and it may

be observed, that in the strongly sculptured ridges of most of the species, a nearer approach is made to the coronated *Geomitra* (*fig.* 20.), than to any other land shell. The last sub-genus to be noticed was long ago characterised by the masterly pen and pencil of Guilding, but seemingly overlooked by our conchologists; it is his *Siphonostoma* *, and is distinguished at once both by the animal and its shell (*S. costata* Guild., *fig.* 22.). The foot is remarkably short, while the spire of the shell is deciduous, *i. e.* falling off soon after it has reached maturity; sometimes, indeed, the animal has been captured before this process takes place: the shell is then remarkably beautiful, exhibiting as many whorls as *Macrospira*, but with this difference, that the upper portion is gradually attenuated to a fine point: this type is thus separated from *Macrospira*, not only by its deciduous spire, but by its round aperture and its thickened lips, which gives it all the aspect of a *Cyclostoma*, except that the margin of the lips, in some species, is even detached from the body-whorl. That there will be intervening modifications between each of these *sub-genera*, so that they may be blended more harmoniously together, can admit of little doubt: our only regret is, at present, that they are too strongly marked and distinct; nevertheless, we may feel confident, after studying the annexed table, that these forms follow each other in the order in which they are now placed. We insert in this place the series of the *Clausiliæ*, which represent *Pupa*, in order to show the intimate relations of the two groups; but we shall subsequently return to that genus, because it forms part of the sub-family *Achatinæ*.



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* Guilding imposed this name after he had discovered that *Brachipus* had been used by us to designate a group of birds.

Analogies of the Genera PUPA *and* CLAUSILIA.

Sub-genera of PUPA.	*Analogical Characters.*	Sub-genera of CLAUSILIA.	Genera of the HELICINÆ.
Megaspira.	Sub-typical; whorls numerous, all persistent; umbilicated.	*Balea.*	HELIX.
Siphonostoma.	Typical; spire deciduous; lips generally detached from the body-whorl.	*Clausilia.*	GEOTROCHUS.
Plicadomus.	Outer lip with the margin considerably dilated, and the edge reflected.	*Macrodontes.*	PUPA.
Pupa.	Cylindrical, with numerous whorls.	*Pupella.*	?
Gonospira.	Spire of few whorls, and very obtuse.	?	HELICELLA.

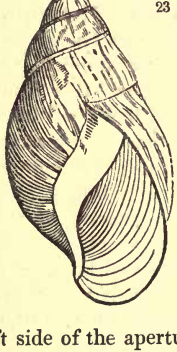
The resemblances between the sub-genera of *Pupa* and those of *Clausilia* are too obvious to be dwelt upon; but those between the first column and the last require some explanation. The spire of HELIX is always obtuse, so is that of *Megaspira;* in GEOTROCHUS and *Siphonostoma*, on the contrary, the terminal portion of the whorls is acutely conic; and this form is carried to such an extent in the deciduous portion of some species, that they actually put on the appearance of being long-spired trochiform shells, instead of a portion only of that to which they really belong. Helicella and *Gonospira* agree in the paucity of their whorls; while the fifth type, which should represent *Pupa*, has not been determined. If we wished to carry our analogies into the zoophagous tribes, it is clear that the strombiform type is the third, and the volutiform the fifth, of the above series.

(158.) We feel unprepared to offer any definite opinion on the extent or the subordinate types of the genus *Helicella;* it stands at the confines of the HELICINÆ and the LUCERNINÆ, and therefore may be supposed to partake in the characters of both. We even think that several of the perfectly discoid shells, now arranged with *Cyclostoma*, such as *Cy. planorbula**, will event-

* Ency. Méth. 461. fig. 3.

ually prove the real types of this group, which represents *Cyclostoma* among the HELICINÆ.

(159.) The ACHATINÆ, as we have already shown, constitute the sub-typical group, representing in their own family the zoophagous tribe. This analogy is seen in two ways: first, they are the most spiral of all the *Helicidæ*, just as the *Zoophaga* are the most spiral of all the *Testacea;* secondly, they are the only ones where the indication of a basal channel is seen, as if to prepare us for the full development of that character in the next great tribe which succeeds this. But setting aside all these considerations, at least for the present, we will at once proceed to characterise the five genera into which they appear to divide themselves. 1. In *Achatina*, properly so called (*A. marginata*, Sw. *fig.* 23.), the basal extremity of the pillar is truncated, so as to present a distinct separation between it and the outer lip; this lip also is always thin and sharp-edged at every period of age. 2. In *Bulimus*, on the contrary, the outer lip is more or less thickened and reflected backward; while the inner lip — always absent in *Achatina* — forms either a little fold just below or near to the umbilicus, or is continued up, and spreads a polish over the left side of the aperture: the general shape of the shell in the typical sub-genera of both this and the last is obovate, having the body-whorl much the largest, and the aperture without teeth, except in the sub-genus *Auricula*. This leads to the next or 3d genus, *Clausilia:* in these the spire is excessively long in proportion to the aperture, the basal or body-whorl being hardly larger than the others; and the aperture, moreover, is furnished with various folds, or toothlike process. The 4th, *Helicina* (*fig.* 18. *b*), is distinguished at first sight by its



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rather depressed form, but still more by its semicircular aperture, always closed by a horny operculum: the typical species are also peculiar from having a narrow notch, or rather slit, at the base of the outer lip. The 5th and last genus is *Cyclostoma*, distinguished by its mouth and operculum being perfectly circular; the margin of the lip is also more or less dilated into a fringe or thickened rim. We shall now take each of these genera, and describe what appear to us the types of form or sub-genera in each.

(160.) The first and typical genus, ACHATINA *Lam.*, includes the largest sized shells of all those inhabiting the land: they are chiefly found in Africa, where the natives use them as food, and expose them for sale in the markets. The inside of the mouth is sometimes of a brilliant rose-colour, and the outsides of nearly all are elegantly marbled with white; but, as the epidermis is very tenacious, the ground colour appears olive. The body-whorl of these typical species is large and ventricose, the outer lip simple, and the whole shell solid: but in the next type, or *Cochlicopa* of Férussac*, the body-whorl is more slender and cylindrical, and the shell is placed very much towards the end of the disk or foot of the animal, which makes this part appear very short: by degrees, however, the spire becomes lengthened, and the body-whorl proportionably smaller; and in these aberrant species, nearly all of which are longitudinally striated, the margin of the outer lip is more sinuated. This elongation of the spire prepares us for the sub-genus *Macrospira* Guild., where the spire becomes excessively long and cylindrical; yet the lip is still very thin, and the pillar is truncated, or notched at the base, precisely as in all the other types. In one or two species we observe, for the first time, a thickened fold in the middle of the pillar, analogous to what is seen in some of the *Auriculæ* and the *Pupæ*. Now,

* We adopt M. Férussac's names whenever they have a right of priority and are classical; this group has been called by the strange appellation of *Polyphemus*, as if the animal had not two eyes, but one only!

this same thickening of the pillar into a central fold is observable in *Leucostoma*,—a name by which we now designate a remarkable little shell (*fig.* 24.) of the same shape as the more elongated *Achatinellæ*, but with the addition of a thick gibbous mass of white enamel placed on the top of the aperture within, where the outer lip joins the body-whorl: this little pad, in short, is exactly the same as what is seen in *Melanopsis*,—the base is distinctly emarginate, and the outer lip thin; but then the substance is more like that of a marine than a land shell, and both the interior of the aperture, and the outside of the whorls, are transversely striated: the space between the upper pad and the commencement of the plait on the pillar is without enamel, and is so short that it has the appearance of a deep notch: that this shell, however, either by affinity or analogy, has a strong relation to the types where we now place it, admits of little doubt; our difficulty lies in determining between these two relations. If not a marine, it may be an amphibious species; in this respect it seems to have a relation of analogy to *Melanopsis*, as well as one, more near, to *Planaxis*. *Achatenilla* is our fifth and last type. These little shells are remarkable for the beauty of their colours; they are all inhabitants of the Pacific Islands, where they are used as bead-like ornaments. They are at once known by the thickened rim on the *internal* part of the outer lip: were this rim *external*, nothing but the truncated pillar would prevent these shells being placed with the *Cyclostomæ*. With *Achatinella*, in fact, the circle is closed. Its connection to *Achatina* proper, with which our survey began, is effected by that well-known shell, the *A. virginea*, which is almost an aberrant *Achatinella*: in this well-known species, the aperture is very oblique, as in *Achatinella pica*, and the pillar, like that shell, considerably turned inward. The thickening on the inner margin of the outer lip is not

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observed in young shells; and even in those which are adult it is very slight, yet it is distinguishable. In the typical *Achatinæ*, on the contrary, the base of the pillar is turned outwards, the mouth is not oblique, and the whole of the outer lip is so thin and fragile, that it breaks on the slightest touch: a more intimate union, in short, cannot possibly exist.

(161.) Having now, to all appearance, closed the circle of *Achatina*, we may compare it with the primary divisions or genera of this sub-family.

Analogies of the sub-genera of ACHATINA.

Sub-genera.	*Analogical Characters.*	Genera of the *Achatinæ*.
Achatina.	Large; ventricose; strictly typical.	ACHATINA.
Cochlicopa.	Body-whorl more contracted; spire more lengthened.	BULIMUS.
Macrospira.	Shell cylindric; spire excessively long; the body-whorl small; aperture short, nearly round.	CLAUSILIA.
Leucostoma ?.	Outer lip with a distinct notch at the base; inner lip not thickened internally.	HELICINA.
Achatinella.	Lip thickened; aperture nearly round.	CYCLOSTOMA.

This result of following the course of affinities is important, as showing that the modifications of the spiral snails are regulated on a uniform and a very simple system. The more experienced zoologist need hardly be reminded, that, in comparing *Cochlicopa* with *Bulimus*, we institute the comparison with that division of the latter genus which is sub-typical, because *Cochlicopa* is also sub-typical: in both these the spire is as long, and generally longer, than the body-whorl; whereas in the pre-eminently typical *Achatinæ* and *Bulimi*, the body-whorl is ventricose, and the four whorls of the spire short. So beautifully do the greater part of these five sub-genera of *Achatina* blend and pass into each other, that it is no easy matter to determine where one ends

and the other begins. *Leucostoma*, however, is an exception; it is more isolated, and consequently its present position is very doubtful. There is also a hiatus between *Leucostoma* and *Achatinella;* but then this last is so perfectly connected to *Achatina*, that nothing can separate them. Thus we have four fifths of a circle absolutely perfect; so that, if *Leucostoma* had been undiscovered, and the fifth type entirely wanting, still this deficiency would not affect the general principles of our arrangement,—we should still have four of the sub-genera intimately representing four of the genera; and we should conclude, by inductive reasoning, that the fifth of the former, when discovered, would represent the fifth of the latter.

(162.) The most numerous in species, and hence the most varied in their forms, of all these sub-genera, is that of *Achatina* proper. In consequence of this variation, the species, as is usual, assume the forms of the genera and families which surround them; so that they might be called sectional types. An instance of this we have already shown in *Achatina virginea*, which, with its allies, obviously represents *Achatinella;* then comes *Achatina Zebra*,, &c. as the pre-eminent types of all: following this, we have such shells as *A. elongata* Sw.* &c., with their longer spire, and thus assuming one of the chief characters of *Cochlicopa;* while *A. crenata* †, and *perversa* †, &c., by their still more produced spire, immediately remind us of *Macrospira:* the depressed form of *Ach. Sultana* ‡ finds its prototype in the unusually depressed *Helicinæ;* and thus we have, in this single sub-genus, indications of all the genera of the sub-family. This is sufficient to show the necessity of rigid analysis, before we can determine what is the *rank* of a particular division, whether it be sectional, sub-generic, or even generic: the same may be said of higher assemblages; for it is impossible to know, *à priori*, what groups are of the rank of sub-families or

* Chem. pl. 119. f. 1124, 1125. † Zool. Illustrations, 1st Series.
‡ Exotic Conch.

families, before the whole tribe has undergone a careful examination.

(163.) The foregoing series, constituting the sectional types of our sub-genus *Achatina*, will be rendered more plain to the general reader, if thrown into a table in the following manner: —

Analogies of the Species in the Sub-genus ACHATINA.

Sectional Division of the Species.	*Analogical Characters.*	Sub-genera of ACHATINA.	Genera of the ACHATINÆ.
A. Zebra.	Ovate; ventricose; spire short; outer lip simple, not sinuated.	*Achatina.*	ACHATINA.
A. elongata.	Ovate; aperture nearly or quite entire; spire more lengthened.	*Cochlicopa.*	BULIMUS.
A. perversa.	Spire lengthened and attenuated; body-whorl short.	*Macrospira.*	CLAUSILIA.
A. Sultana.	Spire rather depressed; base deeply notched.	*Leucostoma?*	HELICINA.
A. virginea.	Aperture nearly round; lip margined.	*Achatinella.*	CYCLOSTOMA.

Now, this is the smallest group which can be made out, next to the actual species which come under each section; and yet every conchologist who possesses an extensive series of these shells, or even of those we have named, must perceive that no other divisions, or sections, can be formed with any degree of propriety; that is to say, if he were asked to single out the most diversified forms from the sub-genus *Achatina*, the above are those he would probably fix upon. Now, this series, small as it is, turns out to have a circular succession; and not only that, but likewise to represent all the sub-genera and genera of the family. Hence it would seem that the essential character of this sub-genus is to have the contour of the aperture simple — not sinuated or dilated, as in the next sub-genus, *Cochlicopa*. The *Cochlicopa maculata* thus seems to be neither an *Achatina*, nor a distinct sub-genus, as some have imagined, for we do not believe it is a marine mollusk.

(164.) The preceding analysis of *Achatina* inci-

dentally explains the essential characters of *Cochlicopa*. Quoy and Gaimard have figured the animal of the last sub-genus, and M. Férussac of this, which is distinguished by the very backward position of the shell; but the typical form of *Cochlicopa* appears to be oblong ovate, the spire and aperture nearly equal, the whole shell distinctly striated longitudinally, and the outer lip forming a sinuated curve near its base; the substance is almost always very thin; and the colour is light fawn, never marbled or banded transversely, but sometimes longitudinally: those species which pass into *Macrospira* have such a long spire, that, but for the oval aperture and regular striæ, they would not be known. The species appear confined to the tropical latitudes of the Old and the New World. On the remaining sub-genera, viz. *Macrospira* Guild., *Leucostoma*, and *Achatinella*, nothing more can here be said.

(165.) The next genus, BULIMUS, is a most extensive and varied one. It represents the typical *Helices*, or snails; and has, consequently, the aperture perfectly entire, the end of the pillar being blended with the outer lip: except in one of the sub-genera, *Auricula*, the pillar has neither teeth, folds, nor plaits; and even in this solitary group, the largeness of the body-whorl, the shortness of the spire, and the thickened margin of the outer lip, are all certain indications of its belonging to the genus *Bulimus*. The *Bulimi*, in fact, possess all the characters of the genuine *Auriculæ*, but without their folds. There is no perceptible difference in the animals of the two typical sub-genera; and that of two of the others are unknown.

(166.) We shall commence the survey of this extensive group at that point where it joins *Achatina*. This union is effected by our new sub-genus *Leptospira*, which, as its name implies, has the spire excessively long and slender; their form, in fact, is precisely like that of the *Macrospira*, but the aperture is entire, and the outer lip thickened. A remarkable shell in our cabinet, once the property of the duchess of Portland,

exhibits the typical perfection of this form: but there are others, much smaller, where the outer lip is thin; and these are the connecting links between this and *Macrospira*. The well-known *Helix decollatus* Linn. seems to belong to this sub-genus, and conducts us immediately to *Bulimulus* of Leach. We now come to shells of the ordinary shape; the outer lip is rather thin or scarcely reflected, and the inner so little developed that it merely forms a thin plate over the umbilicus, where this latter exists. Before we had sufficiently analysed this family, we were little disposed to adopt this sub-genus. Its characters are so very slight, and the greater or lesser reflection of the outer lip is so variable, that we did not think such considerations alone were sufficient to authorise the separation of these shells from *Bulimus:* more particularly as the exquisite drawings of Guilding did not show any outward difference in their animals. But no sooner had it become evident to us that *Bulimulus*, in fact, was the representative not only of *Zonites*, but of *Achatina*, than the full value of the distinction became manifest. There are not many sectional forms among these shells, which are all rather of a small size; but some, as the *Bulimulus undulatus*, *Antiguensis*, and *Proteus* Guild., are very elegant. The third sub-genus, or *Bulimus* proper, is a very numerous one. The fact is, that, being the pre-eminent type of all these sub-genera, it contains representations of all, and under more modifications than are found in *Achatina* proper. As we shall return to these shells subsequently, we may now pass on to *Auricula*, the fourth sub-genus, which, with the general form of *Bulimus*, although less ventricose, unites the peculiar character of having one, or sometimes two, plaits on the pillar near the base of the aperture. The next genus, hitherto overlooked, is *Gonyostoma* (*fig.* 25.), represented by the *Bulimus* of that name. The length of its spire, and the

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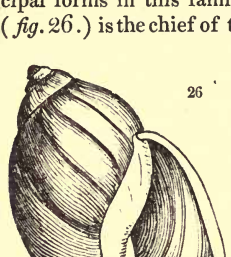
distorted aspect of its mouth, — although quite unique in this group, — are not its only characters; for at the base of the aperture is a little emargination or notch, analogous to what is seen in *Helicina*, *Leucostoma*, and *Anastoma*. By the length of its spire, it evinces such an affinity to *Leptospira*, that we insensibly find we have returned to the group we commenced with. The sub-genera of *Bulimus* thus form a circle, without the absence of a single link in the chain of continuity.

(167.) The sub-genera *Bulimus* and *Auricula* are the only two which will require further illustration. The first, from being pre-eminently typical, contains, like *Achatina*, sectional types, representing the five principal forms in this family. The *Bulimus hæmastomus* (*fig.* 26.) is the chief of these, and is an exact counterpart of the *Achatina perdix* Lam. of the opposite circle. It is a large ventricose shell, with a spire much shorter than the body-whorl, and of only four volutions. In the next type, *Bulimus interruptus** of Lamarck, these proportions are not preserved; the form is more slender, the body-whorl less ventricose, the spire more lengthened, and the whole aspect reminds us of *Achatina regina*† and its allies. These are followed by such shells as *Bul. lubricus* Lam., having very much the cylindrical form of *Pupa;* the outer lip is nearly round, but there is no inner lip, or any tooth in the pillar. In the third modification we see a complete prototype of the sub-genus *Goniostoma*, in that singular shell the *Bulimus Lyonetianus*, where the aperture protrudes on one side, and appears distorted. Last of all comes those small Pacific species (mistakingly separated as a genus, under



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* Chemnitz, pl. 101. fig. 938, 939.

† Zool. Ill. 1st Series.

the name of *Partula*), where the margin of the aperture, instead of being completely reflected, as in all the other types, is only very much dilated or spread out. This peculiar character brings us, of course, to the confines of the sub-genus *Bulimulus;* and by such shells as the *Bulimus melanostomus* of Brazil (which will completely answer to the characters given of *Partula**) we return again to *B. hæmastomus*. By arranging these species in a column, as sectional divisions, they will be found to represent the primary types of the spiral land shells in the following manner:—

Analogies of the Sectional Types of the Sub-genus BULIMUS.

Genera of the *Achatinæ*.	Sectional Types or Species.	*Analogical Characters.*	Sub-genera of the *Bulimi.*	Sub-genera of the *Achatinæ*.
BULIMUS.	*Hæmastomus.*	Shell ventricose; spire short; aperture in the typical species always rosy.	BULIMUS.	ACHATINA.
ACHATINA.	*Interruptus* Lam.	Shell more slender; spire elevated.	BULIMULUS.	COCHLICOPA.
CLAUSILIA.	*Lubricus.*	Spire lengthened; basal volution smaller or very little larger than the next.	LEPTOSPIRA.	MACROSPIRA
HELICINA.	*Lyonetianus.*	Aperture distorted, with a distinct notch at the base.	GONIOSTOMA.	LEUCOSTOMA ?
CYCLOSTOMA.	*Australis.*	Outer lip thickened more than usual; a slight fold on the pillar; aperture ear-shaped.	AURICULA.	ACHATINELLA.

* "PARTULA. Conical, smooth, spire equal to aperture in length, consisting of few whorls; aperture auriform; outer lip reflected, broad; inner lip reflected, with a slight prominence on the columella."—*Sowerby's Manual*, p. 77. If the student turn to the figure of *B. melanostomus* Zool. Ill. 1st Series, he will find this description perfectly applicable; yet this latter has been arranged as a *Bulimus*, and placed in a different family.

The variations in the forms of the species are thus seen to be a primary character in all these groups, whether we look to the primary divisions or genera, or to their sub-genera. It is singular how very closely some of the little shells of Férussac's *Partula* put on, as it were, the very colours of the *Achatinellæ*, which they are to represent; and even the "slight prominence on the columella" is analogous to the thickened fold-like termination of that part in some *Achatinæ:* both, moreover, are chiefly found in the Pacific islands; and both, by having the broadest lips of their respective congeners, aptly represent the *Cyclostomæ*.

(168.) The sub-genus *Auricula* is no less interesting than the last; because, although few in species, its relations are unusually complicated. We shall first notice those types upon which there can be few or no doubts, and then advert to such as are questionable. The knowledge which Guilding's drawings of the *Auricula undulata** has given us of the animal, clearly shows its close approximation to that of *Bulimus hæmastomus*, also figured by the same exquisite artist. This fact goes to establish *Auricula* as a division of the *Bulimi*, and we have to consider what other shells show a close similarity to this. The species we may thus select, are the *Auricula Dombeyana, Auris-Leporis, Sileni*, and *Bovina;* and the whole group may be described as shells with the aperture rather larger than the spire, the whorls of the latter few and produced, the pillar one or two plaited, and the outer lip (except in *Dombeyana* †) thickened and reflected on he external edge. This latter definition would exclude *Auricula midæ*, and those other dubious terrestrial species whose spire, although much shorter, is composed of more whorls. We suspect, indeed, that these latter shells are nearly allied (through *Pedipes* and *Melampus*) to *Tournatella;* in which case both them and the sub-genus *Scarabus* must be removed from the *Helicidæ*, and placed

* *Plecocheilus undulatus* Guilding, Zool. Ill. 2d Series, pl. 103.

† I apprehend, however, that in perfectly adult specimens, this species has a similar outer lip to *A. Sileni*.

with the *Turbidæ*. Certain it is, that these animals (made known by the excellent figures of the French voyagers) are very different from the *Auricula undulata;* they have only two short and depressed tentacula with basal eyes, as in *Pedipes**, instead of the usual structure of these organs common alike to *Auricula undulata* and *Bulimus hæmastomus*. On these reasons do we restrict the sub-genus *Auricula* to the characters above stated — at least, until further information leads to a different conclusion. Of all the species of *Auricula* here named, the *Auris-Leporis* (*fig.* 27.) is the most remarkable; the plait on the pillar is not real, inasmuch as it is not solid, but formed by a sharp angle of the body-whorl round the umbilicus; the aperture is large, and so oblique as to appear distorted. It is by this shell that we pass to the sub-genus *Gonidstoma* already mentioned (*fig.* 25.). The five sub-genera of *Bulimus* will thus form a circle, and present us with the following analogies:—

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Analogies of the Sub-Genera of BULIMUS.

Genera of the *Turbidæ*.	Sub-genera of *Bulimus*.	*Analogical Characters.*	Genera of *Achatinæ*.	Sub-genera of *Achatinæ*.
TURBO.	*Bulimus.*	Body-whorl large, ventricose; spire short.	BULIMUS.	*Achatinæ.*
TURRITELLA.	*Bulimulus.*	Body-whorl more slender; outer lip thin, or very slightly reflected.	ACHATINA.	*Cochlicopa.*
SCALARIA.	*Leptospira.*	Spire excessively long; body-whorl small.	CLAUSILIA.	*Macrospira.*
SCISSURELLA.	*Gonyostoma.*	A slight notch or channel at the base of the aperture.	HELICINA.	*Leucostoma?*
MELAMPUS.	*Auricula.*	Outer lip dilated; the margin spreading.	CYCLOSTOMA.	*Achatinella.*

* See an admirable memoir upon this genus by Mr. Lowe, in the Zoological Journal, No. xix, p. 280.

If, therefore, the *Auricula Midæ** and *Judæ* belong to the division of which *Melampus* is the type, they can be so arranged, without any detriment to the above table. The same may be said of *Scarabus*. We have, indeed, formed this arrangement in conformity with the structure of the animals, rather than of their shells; and resting upon this principle, we deem it preferable to err on the safe side, rather than to follow previous authorities on the subject.

(169.) The next genus, CLAUSILIA, has hitherto been thought to form a part of the *Pupæ;* the two, indeed, are united, yet they appear to form distinct groups. The present is distinguished by having the aperture ovate and ear-shaped; while in *Pupa* it is almost, if not quite, circular. The *Clausiliæ*, as a whole, possess the following characters:—the spire is invariably longer than the aperture, which is defended in all but one instance (*Balia* Gray) with little ridged teeth, usually placed upon *both* lips; they are all small and slender shells; and inhabit temperate rather than tropical climates. We arrange them as follows:—1. *Clausilia*, where the thickest or largest whorls are generally in the middle of the spire, the tip of which usually falls off when the animal has added new whorls to its sheli,—a wise provision of nature, observes Guilding, "since, its foot being short, it would not have the power of drawing along so heavy a shell:" the aperture is usually sinistral, but in the aberrant species it is on the right side; it is very small, much contracted above, and is generally beset with teeth on both its sides. In *Balia*, however, these teeth disappear, and the mouth is dextral. The third, *Macrodontes* Sw., is a new and most interesting type, uniting the compressed teeth of *Clausilia*, with the form and size of *Auricula*. The few species we have yet seen of these

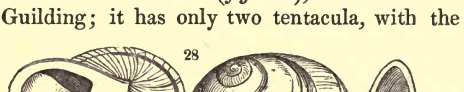
* The representations of the animal of *Auricula Midæ*, given by M. Lesson's Atlas (pl. 9. fig. 1.), are totally different from that of M. Quoy's: the former has the tentacula and eyes of a *Helix*, the latter those of *Scarabus*.—There must be some great error in one of these! Is M. Lesson's design correct?

rare and remarkable shells are all from Brazil; and they establish, in the clearest manner, the passage between the European *Clausiliæ* and the South American *Auriculæ*. We have now arrived at that particular sub-genus which is to connect the present group with the genuine *Pupæ*. This union is effected by those small European shells, hitherto placed in the latter genus, which we have separated under the name of *Pupella*. This sub-genus, in fact, may be looked upon as the common point of union where the sub-families *Buliminæ* and *Achatinæ* are united. They are at once distinguished by having *both* sides of the aperture toothed; and not, as in *Pupa*, the inner lip only. Some uncertainty hangs over what shells are the true types intervening between *Pupella* and *Balia*. The passage, indeed, is very easy, if we suppose it to be made by certain little shells of Europe (as the *P. muscorum, fragilis, dolium,* and *umbilicata* of Drap.) which have no teeth on the outer lip, but sometimes one on the inner; while the shortness of their spires would distinguish them from *Balia:* or this, perhaps, is the place where some of the smaller shells, analogous to our *Gonospira,* should be placed; at all events, we have in *Pupella* such a close approximation to *Balia,* that the circle of the genus *Clausilia* may be considered almost perfect: at all events, we cannot consider either *Alæ* or *Vertego* as sub-generic types, merely because they differ from our *Pupella* by the position of their aperture; while *Azeca* of Leach, as a sub-genus, is equally questionable. We presume, therefore, that the types here mentioned form the circle of *Clausilia.* We have already compared them with those of the *Pupæ,* in conjunction with the genera of the HELICINÆ, we shall now, however, bring the sub-genera of *Pupa* and *Clausilia* more immediately and exclusively together; when it will be more readily perceived that the *hiatus* between *Balia* and *Pupella* might be filled up by some of the shells just mentioned.

Analogies of the Genera CLAUSILIA *and* PUPA.

Sub-genera of PUPA.	*Analogies.*	Sub-genera of CLAUSILIA.
Siphonostoma.	Spire exceedingly long, the upper portion deciduous.	*Clausilia.*
Megaspira.	Spire greatly lengthened, the upper portion persistent.	*Balia.**
Gonospira.	Spire moderate, with few whorls, the tip thick and obtuse; the aperture generally without teeth.	?
Pupa.	Spire moderate, but with many whorls of nearly equal thickness	*Pupella.*
Plicadomus.	Whorls few; the outer lip dilated and broadly margined.	*Macrodontes.*

(170.) Our next genus is HELICINA,—a group of remarkable shells, of which, as near forty species are now known, the sub-genera may be advantageously characterised. This will be done in our systematic arrangement, and in the mean time a few general remarks is all that we can here insert. They are small helix-formed shells, distinguished by their semilunate aperture, which is closed by an operculum. We have not seen, as yet, any intermediate form which renders the passage between them and the last genus sufficiently clear. The animal, as seen in *H. occidentalis* (*fig.* 28.), has been well drawn by Guilding; it has only two tentacula, with the eyes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at the base. In this respect the *Helicinæ*, as Cuvier observes, have a close affinity with the *Cyclostomæ*, many of which are also turbinated shells, and all are

* I should conceive, theoretically and analogically, that *Balia* would represent *Gonospira* by its toothless aperture; and that the prototype of *Megaspira* would be perfectly like *Clausilia*, but without any teeth or folds, and the spire (probably) persistent.

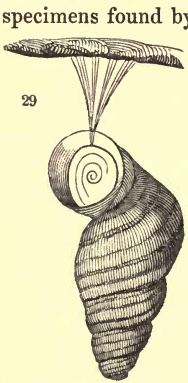
furnished with an operculum. Nothing, perhaps, can better exemplify the artificial nature of Cuvier's *Pectinibranchia*, than his placing *Helicina* between the two fluviatile genera *Ampullaria* and *Melania*, and *Cyclostoma* between *Scalaria* and *Valvata*; in both instances thrusting in a group of land-shells between two others which only inhabit water. This is the more inexcusable, because it did not originate in an ignorance of the animals; and yet he observes that the *Helicinæ*, "judging by the shell, are *Ampullariæ*, in which the margin of the aperture is reflected." * The only reason assigned for placing *Cyclostoma* after *Scalaria*, is "because the aperture is entire, nearly or quite round, and operculated." † This is quite true, but every student will readily perceive that this is merely a remote analogy.

(171.) The genus *Cyclostoma*, like the last, has the sexes distinct; but this is the only one character in which they differ from the other pulmoniferous land and river snails. The passage between this and the last group is rendered unquestionable by such shells as *Helicina elegans* Gray, which has the characters of both united. The typical *Cyclostomæ* are spiral shells, the last whorl being but little larger than that which precedes it. The orifice of the mouth is circular, and is closed by a horny operculum. The pillar is often wanting; but this variation occurs in species so close to each other, that it cannot be considered a sub-generic character. They are usually found in dry arid situations: the island of Malta abounds with them, where thousands may be gathered on the scanty herbage of the rocks; and many elegant species occur in the mountains of Jamaica. On coming to the aberrant sub-genera, we find great diversity in the form, although none in the aperture. In *Cyclophora*, the shells

* Cuvier further remarks that the organs of respiration are arranged as in the *Cyclostomæ*, and, like the latter, they can live out of water. That these two genera are naturally united, both by the animal and the shell, is thus admitted, while we can only say that they are both as terrestrial as the garden snail; they cannot, in fact, live out of the air, as we always killed the animals of our specimens by plunging them into water.

† Griff. Cuv. xii. p. 58.

are turbinated, and resemble those of *Helix*, although the tip of the spire is acutely conical, and not, as in the common snail, depressed. These obviously lead to the typical sub-genus *Cyclostoma;* and these latter, again, to the singular sub-genus *Megalomastoma*, — another admirable group, detected and beautifully illustrated by Guilding; it is the representative of *Pupa*, from which it is distinguished by possessing a horny operculum. *Cyclotus* of the same accurate zoologist is another remarkable type: it is so much depressed, that it almost resembles a *Planorbis*, and, from not having any pillar, the umbilicus is open to the terminal whorl: the operculum is shelly; and although the aperture is round and thickened, the inner lip is carried upwards in the form of a little siphon: this is very remarkable in a species we possess from India, and in another from the West Indies. We are disposed, indeed, to consider this and *Cyclophora* to be the two typical forms of the whole group which represent *Planorbis*, just as the *Lucerninæ* do in the entire family of *Helicidæ*. Guilding founded his group upon one species (*C. fuscescens*), which he found "with the spire corroded," in the woods of St. Vincent; and, unfortunately, all the specimens found by him afterwards were dead shells, so that the animal is still unknown. *Megalomastoma* appears immediately to follow *Cyclostoma*, because the *M. suspensum* Guild., in its shell, is a *Cyclostoma;* but the *M. brunnea* Guild., which is obviously the type, is so elongated as to resemble, at first sight, a *Pupa*. The animal of *M. suspensum* is often found suspended by glutinous threads (*fig.* 29.); it has the mouth rather elongated, proboscis-like, but deeply cleft; the two tentacula rather long, and the eyes at their base. Having now concluded the survey of the four



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great divisions of the HELICIDÆ, which include all the land-shells and slugs, we may enter upon the fifth and last, which are aquatic.

(172.) The LIMNACINÆ is that sub-family which contains the whole of those spiral fluviatile shells which, like all the *Helicidæ*, respire by a lateral perforation. It is difficult for the student to distinguish these river shells from those of the fluviatile genera in the next family; but they are in general much thinner, and in no instance have the *Limnacinæ* even the vestige of an operculum. Like the *Cyclostomæ*, these animals have but two tentacula; but they are, in general, very short and broad, having the eyes at their base: their shells are all very thin, devoid of any bright colour, and the aperture is always simple,—that is, without any thickened margin. They appear to arrange themselves into the following genera:—1. *Planorbis*, where the shell is disk-shaped, and without any pillar, as in our common *P. corneus*. (*fig.* 30.) 2. *Limnæus*, having a very large and wide aperture on the right side, and the basal whorl so large as to contain the whole animal. 3. *Physa*, where the aperture is much smaller, the base contracted, and the mantle so large that its two lobes fold over the shell. In the fourth sub-genus *Potomophila*, the shell very much resembles the last, but the pillar is marked with a distinct plait or fold in the middle: the only species we are yet acquainted with, is the *Conovulus bulimoïdes** of Lamarck. (*fig.* 31.) In this, as in innumerable instances, analogy has been mistaken for affinity. It is clear there is a resemblance between this and the sub-genera *Auricula* and *Conovulus;* but we think there is no doubt that this is a fluviatile shell, and, but

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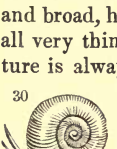

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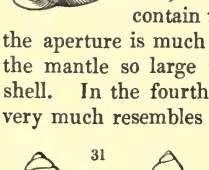

* Ency. Méth. pl. 459. fig. 7.

for this fold on the pillar, it could not be distinguished from a *Limnæus*. The fifth and last type is *Ancylus*, composed of the freshwater limpets (*fig. 32.*), not even mentioned by Cuvier, but constituting one of the most remarkable divisions of the whole group.

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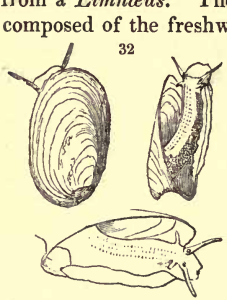


(173.) The five genera, placed opposite to those of the genera of *Achatinæ*, and the sub-families of the *Helicidæ*, will be found to represent each other thus: —

Analogies of the LIMNACINÆ.

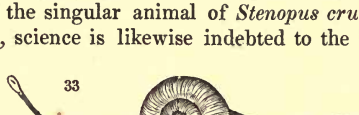
Genera of the *Limnacinæ*.	*Analogies.*	Sub-families of the *Helicidæ*.	Genera of the *Achatinæ*.
Planorbis.	Shell depressed, disk-like; aperture round.	LUCERNINÆ.	*Cyclostoma.*
Ancylus.	Shell fragile, much smaller than the animal.	LIMACINÆ.	*Helicina.*
Potomophila.	Shell thin; aperture large; pillar plaited.	LIMNACINÆ.	*Clausilia.*
Physa.	Outer lip thin; last whorl contracted.	ACHATINÆ.	*Achatina.*
Limnæus.	Outer lip reflected; basal whorl very large.	HELICINÆ.	*Bulimus.*

The general analogies of the whole group may be first slightly touched upon. The *Limnacinæ* occupy that station in the circle of the *Helicidæ*, which corresponds to that of the *Cephalopoda* in the great tribe of TESTACEA. Hence they are all aquatic animals; and if this analogy is correct, it follows that *Planorbis* is the typical group, because, in their flat discoid shells, they perfectly agree with the equally depressed and convoluted *Nautili*. We have seen, also, that in *Cyclotus* a strong approach is made to this very same structure. The little shells of several of the slugs (*Limacinæ*), if no regard be paid to the animals, might very well be

taken for freshwater limpets; so that the analogy is most complete. *Potomophila*, again, is the only type having any fold upon the pillar; and *Clausilia* is the only genus so distinguished among the *Achatinæ*. It is the excessive enlargement of the body-whorl which gives such a peculiar character to the turbinated snails; and this renders them distinct from the *Achatinæ:* and the very same disproportion is observed in all the typical examples of *Limnæus*, of which the common *L. stagnalis* is a familiar example. The near approximation of the amphibious genus *Succinia* to the group we have now gone through, is abundantly obvious. While, from possessing four tentacula, with the eyes pedunculated, it cannot be brought within the limits of the freshwater shells; it is, in short, as Cuvier has happily expressed it, "a *Testacella*, with a very large shell." As the systematic definitions will be hereafter given, we need not dwell longer upon this sub-family.

(174.) The sub-family of *Limacinæ*, which contain the naked slugs, is admitted to be such a natural group, that this part of our survey may be considerably abridged. The first of the typical genera appears to be *Limax*, where the tentacula are four, and, in general, the vestige of a shell is placed near the extremity of the body. The second is typically represented by the genus *Herpa* of Guilding, in which the tentacula are either entirely wanting, or, as in the sub-genus *Onchidium*, they are only two in number, and very short. The determination of *Herpa*, as connected to *Limax*, is one of the most important discoveries in malacology that has been made for many years, not merely as to the fact itself, but to the inferences to which it leads: it may be considered, in short, as the germ, or first incipient developement of this immense family, from which all its innumerable modifications branch off. Its analogy to *Planaria* among the *Parenchymata* is abundantly obvious; a relation well understood by its learned and acute discoverer, who thoroughly un-

derstood the difference between *analogy* and *affinity**, so lamentably confounded by so many other naturalists, even of the greatest reputation. The analogy, again, which the large coriaceous mantle, or shield, of *Onchidium* has to the *Chitons* need hardly be adverted to. The three aberrant genera, *Vitrina* Drap., *Stenopus* Guild., and *Succinea* Drap., have turbinate shells, nearly or quite sufficient to include their bodies; but these coverings are generally thin and semi-transparent, with a wide aperture, a very short or small spire, and, generally, with only the vestige of a pillar. For the discovery of the singular animal of *Stenopus cruentatus* † (*fig. 33.*), science is likewise indebted to the lamented



Guilding: it seems intermediate between *Vitrina* and *Succinea*, and will thus stand as the most aberrant of the whole. The connection of this sub-family to the freshwater snails is obviously effected by *Succinea;* while *Vitrina* leads immediately to *Leiostoma*, among the land volutes. The sub-genera not having yet been determined, we shall pass at once to the fifth division, which closes the circle of the *Helicidæ*.

(175.) The terrestrial volutes, or lamp-snails, LUCERNINÆ, were named by Humphreys,—a name we retain for the whole group, which, as we have already seen, constitute a sub-family.‡ They are well distinguished from the typical *Helicinæ* by three characters, any two

* "Genus *Planariis* facie quam plurimum *analogum*, ut *Limacides* respirationis modo, locis, moribusque *omnino affine*."—*Guilding MSS.*

† See figures and description in Zool. Journal, iii. pl. 15. figs. 1—5.

‡ Lamarck subsequently used the name *Caracolla*, which Férussac wished to set aside for that of *Helicodonta*, a name which, even had it the priority, implies two errors;—first, that they belong to the typical *Helices;* and secondly, that they all have teeth: we consequently cannot adopt the innovation.

of which, in doubtful cases, will almost always be a sufficient guide:—1. The very marked depression of their whole form, and the great number of the spiral whorls. 2. The possession of teeth either on one or on both sides of the aperture: and, 3. The granulated, or distinctly striated, surface of the shell. As our analysis has not been carried down to the location of all the sub-genera, we shall merely, in this place, enumerate the primary groups or genera, with some few of the sub-genera, leaving the rest for the more systematic department of the volume.

(176.) The groups which appear to rank as genera, and which are therefore the first divisions, are the following:—1. *Lucerna*, having the shell flattened and orbicular, the margin always carinated, and generally sharp; the whorls numerous; the surface granulated, but never striated; and the aperture usually toothed, but the teeth confined to the inner lip.* 2. *Lucernella*, equally depressed with the preceding, but the margin of the body-whorl is rounded and convex; the outer lip is always toothed, and there are opposite teeth on the inner lip. These appear the two typical divisions. The three aberrant are, the broad-lipped species of Férussac's sub-genus *Helicella*, having the body-whorl unusually large in proportion to those of the spire, which is flattened; the umbilicus deep; the outer lip spreading, and diffuse, but rarely provided with any toothlike projection: these form our genus *Hemiodon*. The next, or most aberrant type, is composed of a part of Férussac's *Helicogena*, where the shell is granulated, the spire depressed, and the outer lip marked at its base with toothlike notches; the spire is very small, and hardly makes three volutions: this is our genus *Thelidomus*. The wide aperture of these prepare us for *Leiostoma*, having the aperture remarkably large and particularly smooth and glossy, while the glazing of the inner lip is extended very much beyond its usual circumference.

* Except in *Anastoma*, which represents *Pupa* and *Clausilia*.

This latter character is highly important, as showing the analogy of *Leiostoma* to the *Limnacinæ*, and its affinity to the half-testaceous slugs, or the *Limacinæ*.

(177.) Looking to the above genera, with reference to their analogy, they appear to represent the following divisions in their own family, and in the tribe of the *Zoophaga*: —

Analogies of the LUCERNINÆ, *or* LAND VOLUTES.

Genera of the *Lucerninæ*.	*Analogical Characters.*	Sub-families of the *Helicidæ*.
LUCERNA.	Spire more or less conic; whorls numerous.	ACHATINÆ.
LUCERNELLA.	Spire depressed; the margins convex; whorls few.	HELICINÆ.
HEMIODON.	Shell discoid; the spire depressed.	LUCERNINÆ.
THELIDOMUS.	Spire of very few whorls.	LIMACINÆ.
LEIOSTOMA.	Aperture very effuse; inner lip spreading.	LIMNACINÆ.

(178.) The typical genus LUCERNA has one peculiar character, — that although its outer lip is in general toothed or plaited, these plaits are never seen upon the inner lip, or that part of the body-whorl which forms the opposite side of the aperture. They are the largest shells of this sub-family, and are particularly abundant in the West India islands. Although decidedly depressed shells, their spiral whorls are numerous, and are very progressively graduated. We separate them into the five following sub-genera: — In *Discodoma*, the circumference is carinated, the aperture angular, and without teeth; and the edge of the outer lip but slightly, if at all, reflected. In *Lucerna*, the teeth on the edge, or within the outer lip, are very evident. In *Anastoma*, they are extended all round the aperture, which is likewise turned, so as to be nearly on the same plane as the spire. Leaving these, we have an analogous form to *Thelidomus* in several small toothless *Helices* L. (our *Lucidella*), but which evidently, by their spire, belong to this group. *Caracolla* completes the circle by uniting to *Discodoma*,

from which it is nevertheless separated by its circular aperture, analogous in this group, to *Cyclostoma*. As this is the European type, we have preferred retaining to it the sub-generic name of *Caracolla*, that the nomenclature of such well-known species should not be disturbed. The whole group is composed of granulated shells.

(179.) In the second, or sub-typical group, we shall find five sub-genera agreeing with those of the last. As a general character, the *Lucernellæ* may be known by the inner lip, no less than the outer, being provided with teeth: those on the former are either one or (very rarely) two, placed almost transversely, as if to guard the entrance to the shell by rendering the aperture remarkably narrow; the teeth on the outer lip are situated at its inner edge, and have no corresponding indented grooves (as in *Lucerna*) on the outer surface. All the *Lucernellæ*, likewise, are convex on their sides, not carinated. It is only in the sub-genera *Hemicycla* and *Lucidella* that the inner teeth disappear; but the union of the first of these two with *Cyclodoma* is so obvious, that they cannot be placed in different genera. The first form on quitting *Anastoma* is *Polydontes*, of which the type is that singular shell *P. imperator* of Montfort; it is remarkable for its aperture being surrounded by nodulous teeth, obtuse, and resembling large granules, while those of *Anastoma* are more properly folds or plaits: following this comes *Lucernella*, where the form of the shell is often globose, the umbilicus closed, and the teeth very complicated: these lead to the greatly depressed form of *Cyclodoma*, where the shape is sometimes as discoid as in the well-known genus *Planorbis*. These shells are almost always striated; and, although small, are highly interesting. A great number of species inhabit the mountains of North America and Madeira, but probably not one half of those that exist have yet been discovered. In *Hemicycla*, the internal or left-hand tooth either entirely disappears, or is reduced to a little tubercle; the outer lip makes a bold and dilated semicircle, the margin of which is broad and

flattened, without being absolutely reflected backwards. Lastly, we venture to place a few small shells, having something the aspect of *Helicinæ**, as a fifth type, under the name of *Lucidella;* they differ from the last by the comparative smallness of the aperture, which has one or two small teeth on the outer lip, but none on the inner: these appear to pass into *Thelidonta;* and in this manner do we conceive the whole form a circle. Not having yet completed our analysis of the three aberrant genera, *Pusiodon*, *Thelidomus*, and *Leiostoma*, we shall not at present attempt to designate their sub-genera. De Férussac has adopted a modification of Humphrey's name of *Lucerna* (which he writes *Lucena*) for that group, part of which we here call *Leiostoma;* but how far he is correct in placing the richly-coloured shells upon his plates 12, 13, and 14. with that which we designate as the type—may well be questioned. The distorted body-whorl of *Thelidomus*, and its serrated outer lip, render it analogous to *Lucidella*, from which it differs altogether in the few and unequal volutions of its spire. The most interesting genus, however, is that of *Hemiodon*, which has a large dilated aperture, the spire scarcely raised, and a gibbous prominence more or less developed at the base of the outer lip. This is the last remnant of the toothed aperture so common in this sub-family; and accordingly prepares us for the true *Helicellæ*, which compose the first genus among the *Helicinæ*. Thus do the LUCERNINÆ form their circle of affinity, connected on one side to the slugs by *Leiostoma*, which passes into *Vitrina*, and on the other to the land helixes, as just stated.

* Such as *Helicina aureola*, Zool. Journ. i. p. 16. f. 13.

CHAP. VII.

THE PHYTOPHAGOUS GASTROPODS CONTINUED. — THE TURBIDÆ, OR MARINE SNAILS.

(180.) The family of Turbidæ succeeds the last, and, like them, is composed of spiral shells, destitute of any pearly lustre, with the aperture closed by an operculum*: the differences, however, are so slight, that the two families can scarcely be distinguished by their shells alone. The animals of the *Turbidæ*, however, are remarkably dissimilar from those of the *Helicidæ*: they breathe by gills, like all the zoophagous families; and, like them, the mouth of the major part is furnished with a respiratory siphon, and even a probosciform mouth: the tentacula are only two; and the eyes are either basal, or on the sides of the tentacula. The animals, in short, often exhibit the carnivorous structure of the *Zoophaga*, while their shells are completely those of the phytophagous tribe: it is thus that the two groups are connected. The whole of this assemblage are comprised in the following sub-families:—The first is uncertain. 2. The *Ampullarinæ*, or apple-snails. 3. The *Melanianæ*, or black snails. 4. The *Turbinæ*, or winkles. 5. The *Ianthinæ*, or Oceanic snails. A general analysis of these will now be given; this investigation we were, in a manner, forced into, from the impossibility of discovering any bond of union or of affinity between the heterogeneous genera of the *Turbidæ*, as they now stand in our conchological systems.

(181.) The first primary division by which this family may be united to the fluviatile *Limnacinæ*, is

* Except in *Melampus*, and probably *Ianthina*.

somewhat uncertain. There are several fossil genera, as *Enomphalus* Sow., *Orbis*, and *Planaria** of Lea, of a discoid shape, whose animals are quite unknown, and will ever be so, if no recent species are discovered. Their shells, indeed, are intermediate between those of the *Ampullarinæ* and the *Limnacinæ ;* but then this discoid shape is found in so many different families, that their location here would be entirely conjectural. On the other hand, we have our choice of *Valvata* and *Thallicera*†: the first appears to us more like one of the genera of the *Ampullarina;* while the extraordinary animal of the latter, and the singularity of the shell, leads us to view it, with M. Deshayes, more as the representative of a sub-family than of a genus. May this, again, be the natural station of the semi-aquatic genera *Melampus*, *Scarabus*, &c., whose animals have certainly a strong resemblance to those of the *Limnacinæ ?* Into these theoretical questions we dare not enter ; difficulties are opposed to the adoption of each of these theories ; and we shall, therefore, choose that which appears to us, upon the whole, least liable to objection, —namely, the supposition that *Thallicera* stands intermediate between the *Ampullarinæ* and the *Limnacinæ*. The animal of *Thallicera*, like the *Limnacinæ*, is hermaphrodite : the head is large, flat, cleft in two lobes, which bear the two sessile eyes ; but these are without any appearance of tentacula ; the operculum is horny; and the animal is marine. Such is the substance of the interesting facts made known by M. Quoy, who found the *T. Avellana* (*fig.* 34.) in abundance on the coasts of New Zealand. That it is thus allied both to the operculated marine *Pectinibranchia* by its shell

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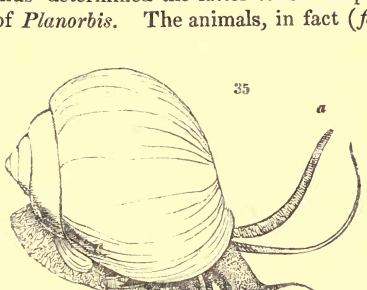
* This name cannot be retained, having been long ago applied to a well-known genus among the *Parenchymata* of Cuvier, and of this work

† M. Quoy, among his other brilliant discoveries in malacology, has the honour of making known the animal of *Ampullacera*. I trust he will excuse my proposing *Thallicera*, as a name not liable, like the above, to be confounded with *Ampullaria*.

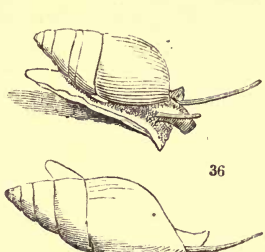
and its habitat, and to the pulmonary fluviatile *Limnacinæ* by its animal, there can be no doubt.

(182.) The shape of the *Ampullarinæ* is most like the garden snails; they are generally globose, the spire very short, and the body-whorl enormous. Many of them are very large, and none are of a small size. They abound in the rivers of tropical countries, both of the New and the Old World. Guilding has admirably delineated the animal of this and the sub-genus *Ceratodes*, and has thus determined the latter to be a representative only of *Planorbis*. The animals, in fact (*fig.* 35.),



of the present group are furnished with a respiratory siphon (*a*); and are, no doubt, carnivorous, as well as herbaceous. Most of them have the operculum horny, but in some it is shelly; and this, joined to the thinness or thickness of the outer lip, may serve to distinguish the sub-genera. The genus *Paludina* seems to represent the last in the rivers of Europe, and is well distinguished by the greater length of the spire, as seen in our native *P. vivipara;* but there are many exotic species: the aperture is narrowed above, and generally protected by a horny operculum. *Nematura* appears a sub-genus whose operculum is shelly, and the aperture still more contracted. With this genus

we also place the European *P. impura* Lam., and the West Indian *P. parvula* of Guilding (*fig.* 36.), the animal of which, according to his drawings, has the tentacula unequal,—that nearest the pillar being almost twice the length of the other. It is as a sub-genus, also, of *Paludina*, that we are disposed to regard *Valvata*.



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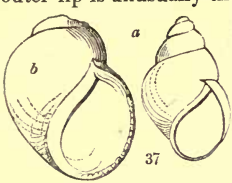
The shells of this last remarkable type are mostly of the same form as many of the helix-like *Cyclostomæ;* the aperture is also round, and closed with an operculum. The animal, which we have not seen, is described by Müller as having the branchia, or gills, pectinated, and projecting from under the mantle, floating externally, and vibrating every time the animal breathes: on the right side of the body is a filament, which resembles a third tentaculum.

(183.) Our third sub-family, MELANIANÆ, is composed of those long-spired fluviatile shells which form the genera *Melania* and *Melanopsis*, together with that of *Planaxis*, as the most aberrant, and two others now first designated as *Paludomus* and *Cerithidea*. This, which we think is the typical sub-family of the *Turbidæ*, is so numerous, that it becomes necessary to characterise the sub-genera; for without this, the theory of their representation could not be rendered intelligible. The animals of these shells are well distinguished from the last, by having their eyes more developed, and placed in the middle of the tentacula, while the mouth is elongated in the form of a proboscis. The genus which makes the nearest approach to the *Ampullarinæ*, in the globular form of the shell, the short spire, and the rotundity of the aperture, is that of PALUDOMUS *Sw.*, formed to receive those short-spired shells which at present are placed in that of *Melania*. The American species form the sub-

genus *Anculosa* of Say (*fig.* 37. *a*)*, and almost resemble nerits. Notwithstanding the thickness of these shells, the outer lip is unusually thin, and the inner is like that of a *Purpura*, being broad and flattened. One or two species now before us are so like young marine turbos, that none but a practised eye would distinguish them. They are, however, strictly fluviatile shells, having a horny operculum; and are abundant in the Ohio. The next sub-genus is *Paludomus* proper (*b*): they differ from *Anculosa* in being sub-spiral like the *Bulimi*, and in having both lips thickened, although not margined by a rim; the outer one is slightly reflected and crenated, and the inner perfect and convex: these seem peculiar to the Indian rivers. In the next sub-genus, *Hemimitra*, the general form of *Paludomus* is preserved, but the whorls are coronated by spines. The whole are readily distinguished from the next genus, by not having the outer lip dilated at its base, the inner lip complete, the aperture wide, and the spire always shorter than the body-whorl.†



(184.) The true genus MELANIA comes next. Amid the great diversities of forms it contains, even as we now intend to restrict it, there may be detected four, if not five, types or sub-genera; yet, with one exception‡, they are all possessed of an entire aperture, and are more or less spiral. The animal, according to Cuvier, has a proboscis-like mouth, and the two tentacula bear the eyes half way on their external side; the aperture is always oval, the outer lip thin, and is generally much dilated at the base. The five types of form, or sub-genera, appear to be these:—1. *Melacantha;* 2. *Melania;* 3. *Potadoma;* 4. *Hemisinus;* and, 5. *Melanella.*

(185.) The first type which meets us after quitting *Paludomus* is *Melacantha*, of which the well-known

* I consider this, however, as a form between *Paludina* and *Paludomus*.
† *Melania conica*, *globulosa*, and *retusa*, of Mr. Gray, Griff. Cuv. pl. 14., belong to this group.
‡ The sub-genus *Hemisinus*.

Melania amarula and *setosa* are typical examples. The spire is short, and the volutions coronated; the inner lip is merely a thin glazing; and the base of the pillar is flattened. It will be remembered that *Hemimitra* is the coronated type of *Paludomus*, and is so like *Melacantha* on a superficial glance, that, but for the difference in their apertures, they might be taken for species of the same genus. From these we are gradually led to the typical division of *Melania*, whose spire is often as long as in *Turritella*. These shells are much lighter than those of the next group, *Potadoma*, which are more solid in their substance; the base of the pillar is not depressed or broad, but convex and comparatively thin; it is likewise, in most of the species, much straighter, while the base of the outer lip is more dilated. All the species we have yet seen of this sub-genus are decollated. We regard, as the most typical character, a slight thickening of the inner lip, particularly at its upper part, because this is never seen in the last group. Our next sub-genus, *Hemisinus*, has hitherto been placed with *Melanopsis*, as the base of the aperture is notched: the type is the *Melania lineata* *: in its general form, indeed, it resembles the preceding shells; but the body-whorl, although more ventricose, is yet contracted at its base, the outer lip but slightly dilated; and the inner lip (now for the first time clearly developed) is complete,—that is, it extends from one extremity of the aperture to the other. The lip of the columella, or pillar, instead of turning inward, turns *outwards*; that part which is covered by the inner lip being straight; while the *sinus*, or notch, at the base, is even wider than in *Melanopsis*, to which this type obviously leads. But before we cross the threshold thus opened to us, we must notice *Melanella*, — another type resembling *Hemisinus* in shape, but having the aperture perfectly entire; the inner lip is much developed, and its upper angle has a callosity precisely like that of *Planaxis*. So remarkably, indeed, does one of these *Melanellæ* re-

* Gray, in Griff. Cuv. pl. 13. fig. 4.

semble the *Planaxis mollis* in size, shape, and colour *, that none but a keen-eyed naturalist would know at first which was which. Both are of the same size and shape — both are white — and both are covered with a pale fawn-coloured epidermis; the only difference between them being the presence or absence of the minute notch at the base of the pillar. We thus find the sub-genera of *Melania* not merely to form a circle, but to represent, in no unintelligible manner, the chief genera of the sub-family.

Analogies of the Sub-genera of MELANIA.

Sub-genera of *Melania*.	*Analogical Characters.*	Genera of the MELANIANÆ.
Melacantha.	Spire remarkably short.	PALUDOMUS.
Melania.	Spire persistent, acute. Typical.	MELANIA.
Potadoma.	Spire obtuse; shell often carinated at the suture. Sub-typical.	MELANOPSIS.
Hemisinus.	Body-whorl ventricose; spire long; base with a wide but not a deep notch.	CERITHIDEA.
Melanella.	Inner lip thickened above; spire short or moderate, pointed.	PLANAXIS.

These remarkable analogies result from the breaking up of the old genus *Melania;* and this is the best apology, if any were needed, that we can make for so many new divisions.

(186.) The next genus, MELANOPSIS, is no less diversified in its minor types, so that we may detect all those which, under a different modification, exist in the last genus. We enter this group by *Melafusus* — a name by which we designate a remarkable fluviatile shell, having the shape of a *Fusus* blended with that of a *Melania;* it differs from *Hemisinus* in having the base more produced, while the spire is shorter. Following this appears the typical sub-genus *Melania,* — at once recognised by its acutely pointed spire being longer than the aperture, the thick enamel at the top of the inner lip, and the inward curve of the pillar: the manner in which the whorls are disposed on this and the next sub-

* Sowerby's Genera, art. *Planaxis*, fig. 2.

genus deserves attention; they are so far imbricate that one overlaps the other to full one half of their length, so that the suture of the basal whorl extends half way up that which precedes it, and gives the appearance of the outer lip ascending on the spire. But among the fossils figured by De Férussac, there are some which have an aspect altogether different: the spire, instead of being acutely pointed, is obtuse, and so short as to consist of only three whorls; the aperture is also represented as much shorter than in any of the recent species, and the base more effuse. Again, there are two species*, which perfectly resemble the sub-genera *Melacantha* and *Hemimitra*, being short, broad, and coronated with a single row of short spines, — the tip of the spire being acute. Now, as these two types obviously accord with *Potadoma* and *Melacantha* in the adjoining circle of the *Melaniæ*, we have not scrupled to designate them as sub-genera, — distinguishing the first as *Melanithes*, as being yet only known in a fossil state, and the second as *Canthidomus*, from its little spines. The confidence we repose in the accuracy of Férussac's beautiful but costly plates, induces us to do this without having ourselves seen any of these shells: but the characters we have stated cannot be doubted; and the links by which these two presumed types are connected with the recent sub-genus *Melanopsis* are so perfect, that they have every indication of being natural sub-genera.† We must now notice a fifth type, which unites something of the characters of those two very opposite sub-genera, *Canthidomus* and *Melafusus;* this is our sub-genus *Melatoma*, founded upon a remarkable Ohio shell sent us many years ago by our old friend professor Rafinesque. It has the general form of a *Pleurotoma* and of *Melafusus*, with a well-defined sinus or cleft near the top of the outer lip; while the inner, though thin, is somewhat

* Plate *Melanopsidæ*, fig. 16. 7. Plate 2. figs. 9, 10.

† Thus the species at pl. 2. fig. 12. plainly connects *Melanithes* with *Canthidomus;* while those on pl. 1. fig. 14, 15. seem to be aberrant to the last sub-genus, leading to the long-spired *Cerithidiæ*. Fig. 6. pl. 2. is clearly a *Pirena*, and fig. 8. a *Cerithium*.

thickened above; the pillar is straight, and the notch at the base nearly as wide as that of an ordinary *Pleurotoma;* the whole shell is marked with regular longitudinal plaits, and coronated on the suture by a row of tubercles. Our specimen, although in bad condition, is still partially covered with a brown epidermis, beneath which the shell is of a livid colour: the aberrant species of *Canthidomus,* as *C. costatus* and *Owenii,* pass into *Melatoma,* and complete the circle.

Analogies of the Sub-genera of MELANOPSIS.

Sub-genera of *Melanopsis.*	*Analogical Characters.*	Sub-genera of *Melania.*	Genera of the MELANIANÆ.
Melafusus.	Base of the aperture notched, but rather effuse.	*Hemisinus.*	CERITHIDEA.
Melanopsis.	Base of the aperture contracted.	*Potadoma.*	MELANOPSIS.
Melanithes.	Tip of the spire obtuse.	*Melania.*	MELANIA.
Canthidomus.	Shell ribbed or coronated; spire short or moderate.	*Melacantha.*	PALUDOMUS.
Melatoma.	Spire moderate; inner lip thickened within.	*Melanella.*	PLANAXIS.

The use of the last, or additional column, which contains the genera of the entire sub-family, is chiefly for the purpose of showing that *Melatoma,* while it preserves its analogy to *Pleurotoma,* agrees also with *Planaxis* in having the base notched, and with *Melanella* by its thickened inner lip.

(187.) The next genus is that of *Cerithidea.* We have now come to the cyclostiform type, which, with the elongate form of *Scalaria,* has an effuse and circular aperture, with the outer lip dilated into a broad fringe, and a very short notch at the base. The lightness of these shells would seem to indicate that they were fluviatile; but as they are slightly variegated, and have no epidermis, we should not be surprised at their being found in the sea,—more particularly as this appears to be the point where the series of fluviatile *Testacea* terminates, and the marine commences. Nevertheless, the great change from *Melanopsis* to *Cerithidea* is not

sudden; for it is here we shall insert, as an intervening form, our sub-genus *Ceriphasia* (*fig.* 38.), founded upon certain Ohio shells resembling *Cerithidea*, but whose outer lip is thin and sharp. Unfortunately, we can find no account of the animal, nor are we acquainted with any shells which will connect these with *Melanopsis* on one side, and with *Cerithidea* on the other. Until our path, therefore, is better marked, we must leave their precise situation as doubtful. There are evidently three or four sub-genera undiscovered or uncharacterised, which belong to this genus. One of these, we suspect, will be found in certain small species, figured as *Melanopsides* by M. Férussac: their spire is unusually lengthened; and the whorls are strongly and longitudinally plaited. As our last genus, we introduce *Planaxis*, — the animal of which, having been fully investigated and described by M. Quoy, proves that their shell must be arranged with the *Melanianæ*. It is difficult to conceive why this eminent malacologist should have introduced it near to *Buccinum*, when he expressly says that in the structure of the animal it comes close to *Melania*. If *Planaxis* was to be arranged from its shell alone, it should be placed next to the *Purpurinæ*, since it has the pillar-lip very broad and flattened; it is, in fact, a *Purpura* among the *Melanianæ*, and, like them, the eyes of the animal are placed on short peduncles, close to the base of its two long and slender tentacula. Some of these, like the common species, *P. subsulcata*, has a very short spire; but another, the *P. decollata*, discovered by M. Quoy, has the spire of a *Melania*, while its name seems to imply that the terminal whorls are deciduous.

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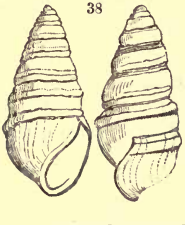

(188.) Having now, as far as possible, analysed this sub-family, a few general remarks may follow. The *Melanianæ* may be viewed as that group of the *Tur-*

bidæ which stand upon the very confines of the phytophagous circle, yet still within its limits: it therefore partakes much more of the tribe which Nature is about to enter upon, than of that she is on the point of quitting; and, consequently, not only the animal, but even the shell, is so fashioned as to exhibit this preponderance to the first rather than to the last group. On this broad principle do we account for the indication of a basal channel seen in all the sub-genera of *Melanopsis*, in *Planaxis*, and in *Cerithidea*. Nay, to such a refined point is this principle of gradual developement carried, that we hardly know, at present, where to draw a line of demarcation between the *Turbidæ* and the *Strombidæ*; not, of course, in their pre-eminent types, but in those which are aberrant. *Cerithium* is in one, and *Cerithidea* in the other. Their typical forms are easily distinguished. But in which of these are we to place the apparently anomalous sub-genus *Ceriphasia?* and how delicate and refined are the characters by which this is proposed to be detached from the fluviatile *Potomidæ* of Brongniart! It is here, then, rather than among any other of the *Melanianæ*, that we should say the two tribes actually unite. All modern writers, indeed, have perceived this; and some have gone so far as to unite all the sub-genera of *Melania* and *Melanopsis*, and many of the *Cerithinæ*, into one genus. It is quite clear, however, that if this principle be acted upon, the greater our knowledge of the *Testacea* is enlarged, the more must the number of our genera or divisions — call them what we will — be reduced. New species bring new modifications of forms; and these, filling up intervals, and softening down differences, will so blend groups which are now in some degree detached, that the whole, in process of time, will present but one continued chain of gentle gradations. No "well-marked divisions," in the sense which the term has been used in, could by any possibility exist. Our tribes and families, genera and sub-genera, would melt, one after the other, into the general mass — they would be abolished — and our

divisions would be species, and species only. We may be pardoned, perhaps, for alluding to this great error in our nomenclature more than once, because it appears to us to be fraught with more inconveniences — not to say evils — than those of an opposite nature; and because, in the group now before us, we have been obliged to name and define so many new divisions. These divisions, in fact, will show more forcibly than any general arguments, the perfect confusion in which we must have exhibited this portion of the *Testacea*, if we had left them under the three or four genera where they now stand in the latest systems of conchology.

(189.) That the *Turbinæ* follow the *Melanianæ* is evident from the close connection of *Cerithidea* Sw. with *Scalaria* Lam.: the little basal channel of the former gradually lessens in the aberrant species, until, in one we possess from Florida, it is a mere vestige. This affinity fixes the station of the sub-family before us better than all theoretical reasons. The *Turbinæ* are all marine shells, and possess a perfectly entire aperture. Their typical genus, *Turritella*, is subulate, or awl-shaped, so as to have the spire very long. All the *Turbinæ* have their aperture closed by an operculum, and their substance is never perlaceous. From overlooking this very obvious difference, even in the shells, all conchologists, excepting Humphrey, have blended them with the *Trochidæ*. Cuvier, at least, from the knowledge he had of the difference of the animals, should have not fallen into this error: the confusion has been still further increased by M. Ferussac; for he has given to the *Turbines* of Humphrey the new name of *Littorina*, and transfers that of *Turbo** to Humphrey's *Senectus*. We do not usually trouble the reader with these misnomers, but we shall correct them as they occur. Our genus *Turbo*, therefore, is that of Linnæus and Humphrey, the last of whom we also follow in placing all the perlaceous ones in that of *Senectus*. There are so few variations or sub-genera in the TURBINÆ, that we shall

* The common winkle, *Turbo littoreus* Linn., is the type.

here chiefly confine our notices to the five leading genera: these appear to be *Scalaria* Lam., *Turritella* Lam., *Turbo* Humph., *Melampus* Mont., and *Scissurella* D'Orbigny.

(190.) The genus *Scalaria*, as the circular-mouthed group, represents *Cyclostoma*: the typical form seen in the common wentletrap (*S. pretiosa* Lam.) has no pillar, although it is a long spiral shell. These lead obviously to *Turritella*, where the shell is even more attenuated, so that the whorls are fully as numerous as in *Terebra*, which it thus represents. *Turbo* (*pulchra, fig. 39.*) is the next genus, differing chiefly, as regards the shell, in the inner lip being broad and flattened, and the spire often very short, or not longer than the aperture. There is certainly a resemblance between many of these shells and the more globose *Trochidæ*, particularly the sub-genera *Pagodella* and *Echinella*, which are not perlaceous; but the great thickness and depression of the pillar in *Turbo*, its perfectly round aperture, and the convexity of the body-whorl, are sure marks of distinction. In the invaluable plates of M. Quoy, there is a figure of the animal of a species of *Turbo* (under the name of *Littorina*), which shows it to have almost a zoophagous structure, — so totally different indeed from that of *Trochus*, that they have even no analogy to each other. The same may be said of *Phasianella*, which is only a long-spired *Trochus*, analogous, indeed, to *Turritella*, but with the short mouth and lateral filaments of the *Trochidæ*.

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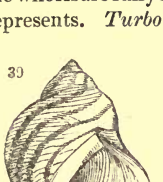

(191.) The next genus, *Melampus* Montf., is one of particular interest. It was originally proposed by Lamarck; but upon being told that they were land shells, he abandoned his name of *Conovulus*, and incorporated the species in his genus *Auricula*. This was clearly a retrograde movement; for, even had his information been correct, the difference of these two genera on one hand, and the close resemblance between *Tornatella* and *Melampus*, is too ob-

vious to be overlooked. From the MS. notes of Guilding, it appears that these little shells are not more terrestrial than the other marine *Turbinæ*. In regard to amphibious *Testacea*, or such as live both in and out of water, the following valuable remarks are taken from the Guilding MSS. "The genus *Melampus* commonly inhabits the shallow parts of the coasts, but I have received *Melampus coniformis* ? from stagnant fresh waters on the shores of Tortola, which only communicate with the sea occasionally during heavy rains, when the accumulated water is discharged with it. They are found creeping on the mangrove roots; and, like manyof the *Neritidæ* and *Turbinidæ*, are perfectly amphibious, and very tenacious of life. The latter, indeed, though they descend to feed at night, are often seen on the trees of the coasts, and on the dark black rocks elevated above the surface at high water; they remain stationary on the latter during the hottest hours, even when it is painful to walk on them from their great heat. The difference of the waters inhabited by testaceous *Mollusca* does not, as was once supposed, offer a certain guide for the division of genera. Many of the *Neritinæ*, for instance, dwell in the fresh waters of rivers, while I have dredged up others in the bays and shallows of the ocean." *

(192.) This genus, as far as we can at present judge, seems to be composed of the following groups:—*Geovula* Sw., *Melampus* Montf., *Rhodostoma* Sw., *Pedipes* Adanson, and *Scarabus* Montf. All these are clearly separated from the sub-genera of *Turbo* by the total want of an operculum; while from *Auricula* they are still further removed by the branchia being pectinated, by having two tentacula, with the eyes at the base, or sessile, and in the shells being more solid. The highly interesting and valuable essay by Mr. Lowe on *Pedipes* and *Melampus* †, satisfactorily proves that these cannot belong to the *Pulmonaria* of Cuvier, and are therefore excluded from the land shells, or *Helicidæ*. But whether the genera *Geovula* and *Scarabus* have their

* Guilding's MSS. † Zool. Journ No. xix. p. 281.

branchia also pectiniform, we have no means of knowing. The aspect of their shells, however, induces me to place them for the present in the same group, more especially since we have already shown they would altogether disturb what we think is the natural series of *Auricula* and *Clausilia*. We do not attach any importance to the fact of *Geovula* having an epidermis, because, although the excellent zoologist just named thought otherwise, we possess several specimens of a typical West Indian *Melampus*, where a thin brown epidermis is over the whole shell; and this also is common to the sub-genus *Rhodostoma*. The peculiar depression of the numerous whorls of the spire in *Geovula*, *Scarabus*, *Melampus*, and *Rhodostoma*, strikingly contrasts again with the few and produced volutions of the true *Auriculæ;* and the whole are separated from *Tornatella*, by the animal of the latter having an operculum, and being differently formed. *Tornatella*, in fact, seems to represent the sub-genus *Melampus;* while *Truncatella* of Lowe, probably, does the same in the circle of *Turritella*. The whole of this sub-family, however, requires much more attention than we have yet been able to give it.

(193.) We place the genus *Scissurella* as the only type of our last division, from a belief that it is analogous to *Ianthina*. It was first characterised by M. D'Orbigny, one of the most eminent naturalists of France, who found his specimens among sea sand. It is very minute, and the animal is unknown: its general shape is that of *Sigaretus* or *Vitrina*, but there is the same sort of long narrow slit in the outer lip as is seen in the *Pleurotominæ*, in *Pleurotomaria*, and in *Ianthina;* thus we have numerous analogies, while in affinity we consider this genus to be the patelliform type of the *Turbinæ*. The very beautiful figures in Mr. Sowerby's *Genera*, is all we yet know of *Scissurella;* but we possess two or three similar shaped shells, which appear closely connected to this type, and probably enter into the same genus.

(194.) We shall now take a rapid view of the five genera which appear to compose the sub-family before us.

These and their analogies may be arranged in the following table: —

Analogies of the TURBINÆ.

Genera of the TURBINÆ.	*Analogies.*	Sub-families of the TURBIDÆ.	Genera of the MELANIANÆ.
TURBO.	Spire moderate, not longer than the aperture.	AMPULLARINÆ.	*Melanopsis.*
TURRITELLA.	Spire excessively long.	MELANIANÆ.	*Melania.*
SCALARIA.	Mouth circular, margined.	TURBINÆ.	*Cerithidea.*
SCISSURELLA.	Aperture very effuse; outer lip sinuated.	IANTHINÆ.	*Planaxis.*
MELAMPUS.	Pillar plaited; spire very short.	THALLICERA.	*Paludomus.*

We introduce two series of analogies in this table, because one will better illustrate what may be thought obscure in the other. The two first set of analogies, *Turbo* and *Turritella*, are particularly strong; for we thus find the needle-like *Melanianæ* represented by *Turritella*, and *Turbo* by *Ampullaria*, both equally ventricose and turbinate. The thick or margined aperture, again, of *Scalaria* and *Cerithidea* exist in no other groups. It must be remembered, also, that the *Turbidæ*, as a family, is the cyclostiform or circular-mouthed group of the phytophagous tribe; and this character runs through the whole group, with the exception of *Melampus: Scissurella* and *Ianthina* have the strongest analogy; and these, with *Planaxis*, have the most effuse apertures of all their congeners. We must confess, indeed, that, but for the discovery of *Scissurella*, we had long imagined that *Planaxis* formed the most aberrant genus of the *Turbinæ*. The last set of analogies is those between *Melampus*, *Thallicera*, and *Paludomus*: it is not very strong; yet, as they are the only shells with plaits on the pillar, they represent the volutes and the land *Auriculæ;* while it seems that Mr. Say has discovered an *Anculosa*, whose pillar bears a plate or fold precisely analogous to that in *Thallicera*.

(195.) Of the next sub-family, represented by the beautiful and delicate *Ianthinæ*, or oceanic snails, little

can be said. The only two genera we can venture to place in it are *Ianthina* of Lamarck and *Trichopodus* of Sowerby. The first consists of those pretty but fragile violet and white snails which so much resemble the *Helicidæ:* the animal has been described by Cuvier, and is so very peculiar, that it cannot be arranged in any of the foregoing divisions, and yet it occupies that place in the *Règne Animal* precisely where we should have placed it, — that is, immediately after *Melampus*. "The animal," observes Cuvier*, "has no operculum; but the under surface of its foot is furnished with a vesicular organ, resembling a bubble of foam, but composed of a solid substance, which prevents the animal from crawling, yet allows it to float on the surface of the water. The head, a cylindrical proboscis, terminated by a vertically cleft mouth, and armed with little hooks, has a bifurcated tentaculum on each side." Nothing, unluckily, is here said of the position of the eyes; but it is sufficiently clear from this short account, and also from the shell, that the *Ianthinæ* belong to the family before us. We follow Lesson in placing the singular genus *Trichopodus* as intermediate between this and the last division, yet coming much nearer to *Ianthina* than to *Turbo*. This brings us to the end of the series; and if, as we believe, *Thallicera* stands between *Ianthina* and *Ampullaria*, we reach again the point from whence we commenced our survey, and thus complete the entire circle of the *Turbidæ*.

(196.) The TROCHIDÆ, as a family, are distinguished from all the phytophagous *Testacea*, both by their animals and their shells; although much more by the former than by the latter. The invaluable researches prosecuted by the French voyagers, more especially by MM. Quoy and Gaimard, joined to the scattered notices in other authors, have so far afforded information on the animals of the TROCHIDÆ, as to detach them from the *Turbidæ*, with which conchologists have hitherto mixed them. The following

* Griff. Cuv. xii. 63.

analysis may, therefore, be interesting, as the most perfect we have been able to lay before the reader.

(197.) The animals of the present family widely differ, both in habits, shape, and anatomy, from those inhabiting the *Turbidæ*. In the first place, their mouth is more like that of the slugs and snails (*Helicidæ*), being composed of two short lips,—the upper, and sometimes the under, of which is cleft and fringed; the eyes, instead of being supported, as in the *Turbidæ*, half way on the tentacula, are seated on two short but very thick tubercles; while the long and slender tentacula are nearly cylindrical, and of equal breadth throughout: the whole structure, in short, is intermediate between the animals of the ear-shells (*Haliotidæ*) and the snails (*Helicidæ*); further, the generality have three long slender filaments on each side of the foot, as long as the tentacula, but the use of which is unknown. In one of the typical groups, and in *Phasianella*, the aperture is closed by a strong, and often very thick, shelly operculum; but in the *Trochidæ*, this covering is horny, except in that particular group which connects them with the *Senectinæ*: in the *Rotellinæ*, again, the operculum is horny.

(198.) The shells, in their typical examples, may in general be recognised both by their pyramidical shape, and by their substance being perlaceous,—a fact always indicated by the rich pearly hue of the aperture. As this is the most prevalent, it is perhaps the best character for the mere conchologist to go by: and yet this will not serve in all cases, because the pheasant-snails (*Phasianella* Lam.) and the carriers (*Onustus* Hump.) are not pearly; and even the most aberrant sub-genera in *Senectus*, *Trochus*, and *Monodonta*, which represent the carriers, are equally destitute of this substance. Nevertheless, all these, excepting the first, have their basal whorl so much depressed or flattened, and their shape so trochiform, that a little attention will soon make the student familiar with them.

(199.) We think the following groups are the pri-

mary divisions, and hold the rank of sub-families: — 1. The PHASIANELLINÆ, *Lam.*, where the shell is spiral and obovate, and shaped like a *Bulimus;* the outside is polished, and the operculum shelly. 2. The SENECTINÆ*, or sea snails, resembling the garden snail in form, but perlaceous, and furnished with a thick, round, shelly operculum. 3. The TROCHINÆ, or trochuses, having the shape more pyramidical, the body-whorl flattened, and the aperture closed by a horny operculum. 4. The ROTELLINÆ, or wheel-shells, which are also perlaceous, and nearly discoid in shape, with a thickened mass over the inner lip. 5. PLEUROTOMARIA *Def.*, — a fossil trochiform shell, having a slit on the outer lip, as in the genus *Pleurotoma* of Lamarck. Such are the primary forms, which seem to belong to the TROCHIDÆ. Our information on the animals is partial; but there is enough to guide us in three of the chief groups. Thus the question whether *Phasianella* belongs to this family or the *Turbidæ* has been set at rest by M. Quoy, among whose beautiful figures is the animal of the typical species: the same eminent zoologist has also decided the relations of *Senectus* to the *Trochinæ*, by figuring the *Turbo sarmaticus*, — thus showing its affinity to the animal of *Trochus*. The gradual chain of connection between *Trochus, Solarium*, and *Rotella*, leaves us in no doubt that these also form part of the family; but whether *Pleurotomaria* is merely a genus of the latter group, or the representative of a sub-family, must still remain a disputed point. We insert it, however, under the latter supposition, because it will appear by the following analysis, that it can in no wise be incorporated elsewhere.

(200.) The PHASIANELLINÆ, or pheasant-snails, form one of the most isolated genera in the whole of the *Testacea*. That they represent the *Turbidæ*, is obvious; for Lamarck and his followers have mixed

* *Senectus* of Humphrey, *Marmarostoma* (pars) Sw., *Turba* of Cuvier, &c.

them together. Their exterior is the most beautiful of all the *Trochidæ*, not merely by the richness and endless variety of their colours, but from their exterior being almost as highly polished as the olives. The mouth has two cleft and crenated lips; the tentacula are long, slender, and of equal thickness throughout, while on each side of the body are three lengthened filaments. The *Phasianellæ* are nearly all natives of the Pacific Ocean, and have an oval-shaped operculum. One species, of a small size, is found in Britain. This is obviously the long-spired group of the *Trochidæ*, representing in this family the *Turbidæ*, the *Buccinidæ* (wherein is *Terebra*), and the *Cerithinæ*.

(201.) The SENECTINÆ, or snake-shells, were separated by Humphrey from the Linnæan genus *Turbo* near forty years ago; but conchologists have continued, up to this day, to confound the two, or, rather, to misapply their names. This most natural group contains nearly all the largest and the most splendid shells of the family, —all of which we believe, possess a circular and very strong stony operculum.* The body-whorl is always ventricose, and is not depressed, like that of the *Trochinæ;* it is produced at its base, in the typical examples, into an obtuse lobe, analogous to the prolongation of the base of the zoophagous gastropods, yet without any channel. Thus we perceive, at every step, how completely Nature preserves her uniform principles of representation; for it is clear that these *Senectinæ* represent the zoophagous or channeled tribe, just as *Trochus* represents the *Phytophaga*. The snake-shells form themselves into very natural genera. The first, to which we retain the sub-family name of *Senectus*, is known by the spire, although small and short, being always ventricose and pointed, the body-whorl very large, the base produced into a lobe, and the umbilicus altogether wanting. The most gigantic, elegant, and magnificent shells of the whole family enter into this group, which are chiefly natives of the southern hemi-

* Excepting, perhaps, that type which corresponds to *Onustus* Humph.

sphere. The ventricose form of the body-whorl of, course, modifies the shape of the aperture, which is thus always circular, and but seldom oblique. Before we had sufficiently studied this family, we included the foregoing in our genus *Marmarostoma;* but we intend to limit that name to the umbilicated division of Humphrey's *Senectus,* represented by the *M. versicolor**, — the passage from one to the other group being made by our *Senectus coronatus.*† The umbilicus in these is, indeed, small, but very deep; the spire is almost perfectly flattened, the tip obtuse, and the base even more produced than in *Senectus.* It is quite clear to us, that more than one species is confounded by conchologists under the specific name of *coronatus;* since some have an umbilicus, and others not. In all the *Marmarostomæ,* however, the pillar is present; but on entering upon Lamarck's *Delphinula,* the umbilicus is open to the terminal spiral whorl, and there is no pillar: the *Turbo torquatus* of the old conchologists is, therefore, a true *Delphinula,* connecting this genus with the last. Of the fossil shells referred to *Delphinula* we shall not speak; judging from their figures, and from a few specimens we possess, they appear to require a thorough revision, and to contain types very different from those which are recent. Our next genus, if it be really one, contains, at present, but two species, differing in being very slightly perlaceous: they may be compared to *Delphinulæ* without an umbilicus. The name of *Cyclocantha* may explain their round form, and the circle of spines on the body-whorl. *Cidaris* is the last genus, and contains those *Senecti* which have the base destitute of any lobe, the aperture more oblique, the apex of the spire obtuse, and the outer surface almost always smooth‡; the aperture is quite circular, and closed by a thick calcareous operculum. There are many species, of which the beautiful *Cidaris sarmaticus* may be

* *Turbo versicolor* Martini, pl. 176. fig. 1740, 1741.
† Ency. Méth. 448. fig. 2.
‡ Except in our *S. coronata,* which connects this sub-family with the next.

selected as the most typical. By simply following the line of affinity, we thus return to our first genus, *Senectus;* for it is easy to perceive that *Cidaris pethiolatus* has the spire and general aspect of *Senectus,* with the truncated base and smooth surface of *Cidaris.* The circle, in short, is complete.

(202.) The TROCHINÆ naturally follows the last division. The body-whorl, which in the snake-shells is ventricose, is here depressed, and often flattened beneath; and this modifies the aperture, which thus becomes broader than it is high, or transversely oval. It is by these latter characters, also, that the *Trochidæ* are separated from the *Turbidæ,* where the aperture is invariably either round or longitudinally oval. In the last genus of the *Senectinæ,* nature has begun to indicate the change from a round to a transverse aperture. The operculum of all the more typical forms of the *Trochidæ* is horny; but this change is effected gradually. The first genus, consequently, of the *Trochinæ* combines the characters of both subfamilies. *Canthorbis,* in fact, has the depressed aperture of the *Trochinæ,* with the shelly operculum of the *Senectinæ. Canthorbis* is a remarkably diversified group: it contains the largest of the *Trochi,* properly so called, as distinguished from *Senectus;* but in all the shell is nighly perlaceous, the aperture transversely oval, and the operculum shelly.* The five types of form, or subgenera, are all recent; and as their characters will subsequently be given, we shall only, in this place, illustrate them by general observations. All the large, spinous, nodulous, and long-spired *Trochi* belong to this genus, in which there are very few having a smooth surface. It is connected to *Cidaris* by *Rugosus* and *Cookii;* to *Onustus* by the sun-shells; and to the typical *Trochi* by our sub-genus *Carinidea,* into which, as we suspect, will enter the *Trochus Niloticus* of Linnæus,—

* If, as Sowerby mentions, the operculum of the *Trochus Niloticus* is horny, instead of shelly, it will be the osculant species connecting *Canthorbis* to our genus *Trochus.*

a very remarkable shell: out of hundreds, we have never yet seen a specimen, however large, which had a perfectly formed mouth, so that we feel somewhat undecided as to its precise station. In a young state, the basal volution is often perfectly flat, and even concave; and this gives the margin precisely the same carinated edge as belongs to *Carinidea;* but when more advanced it becomes convex, as in the genuine *Trochi,* — thus uniting, at different periods of its growth, the characters of the two groups between which it appears to stand.

(203.) Having now shown, by the foregoing details, the union of the *Senectinæ* and the *Trochinæ,* we shall briefly characterise the remaining genera of the sub-family we are now upon, and then notice their subgenera. *Canthorbis* has already been defined: following this is *Trochus,* properly so called, where the umbilicus, if it exists, is never toothed, and very rarely channeled. In *Monodonta,* these characters are reversed; the umbilicus, if present, is always either toothed or channeled, and the aperture striated. The fourth genus is *Solarium,* where the umbilicus is so large as to reach to the apex, the pillar is absent, the shell nearly discoid, and the aperture without any defined lip. The last genus is *Onustus,* long ago separated by Humphrey, to include those singular and half-formed shells, called by collectors, *Carriers.* Of the animals by which these are formed, we as yet know nothing; but their shells are composed partly of the usual calcareous substance, and partly of little stones or fragments of other shells, which the animal gathers up and incorporates on the outer surface of its own habitation. A gradual series of intervening forms unites this group on one hand to *Solarium,* and on the other to *Canthorbis;* so that the whole of the *Trochinæ,* being united into one circle, constitute a natural and perfect group. We shall now notice each of these genera in detail.

(204.) Having already spoken of CANTHORBIS, we pass to the second genus, TROCHUS. Were we to make this an artificial group, its definition would be very

easy, for it might then be formed to contain all those small or moderately sized trochuses, which are without a distinct tooth at the end of the pillar, and have a horny operculum. But this definition would break up the natural series. The group, in fact, is so difficult to characterise in general terms, that we suspect its fundamental difference from that of *Monodonta* lies in certain peculiarities of the animals, with which at present we are unacquainted; but if, to the foregoing characters of *Trochus*, we add that one of its sub-genera has a prominent tooth, but no umbilicus, and that another is not perlaceous, we shall then name the only exceptions. The whole genus, then, divides itself into the following five sub-genera: — 1. *Chlorostoma*, where the basal volution is either perfectly flat or concave, the margin carinated, and the outer lip so oblique that it extends half way round the circumference of the shell; the umbilicus is very deep, and is bordered on one side by the inner lip, which is suddenly truncate as soon as it reaches half way round the umbilicus: this leads to *Trochus*, or the typical sub-genus. All our British species, excepting *T. zizyphinus*, come into this division; the umbilicus is more or less deep, and the aperture either entire or with a very slight angle at the pillar: by degrees, however, this angle is so much developed, that it assumes the appearance of a tooth: thus we are led into the sub-genus *Trochidon*, nearly all of which are natives of the southern hemisphere. Some have the tooth as distinct as in *Monodonta*; but they may at once be known by having no umbilicus, even although the inner lip may have a slight marginal groove. But here, as nature has reached the highest point of developement, she again recedes; the spire gradually lengthens, the tooth becomes a simple angle, and we enter on the smooth division of the group, forming our sub-genus *Calliostoma*. The *Trochus zizyphinus* of British writers will give a very good idea of these shells; they are nearly all either perfectly smooth or slightly granulated, of a light and elegant form, a long and pointed spire, and no umbilicus:

several species, but little known *, are found in the Mediterranean ; and these are the most trochiform, — that is, the basal whorl is unusually flattened, which renders the aperture narrow: those from the Pacific, on the contrary, are more ventricose, — thus representing *Cidaris* and the *Senectinæ*. This modification of form is to constitute the passage which here takes place between the five types of *Trochus* and those of *Mŏnodonta*. The last sub-genus, *Pagodella*, is the only one containing shells that are not perlaceous. The student, at first sight, would think this was a most heterogenous group, for it contains species of very different forms: some are so like European *Calliostomæ*, that they might be strictly arranged as such, if the substance of their shell was not regarded ; others are equally conic, but instead of being smooth, are beset with nodulous granules ; while others, again, are formed precisely the same as our first type, *Chlorostoma*, but yet have no umbilicus. But this is at once explained by the situation of *Pagodella*, which is intermediate between *Calliostoma* and *Chlorostoma*. So exquisitely, also, has nature blended this genus with the last-named group, that there is one species, the *Trochus Merula* of Lamarck, which unites in itself still more closely the characters of *Chlorostoma* and *Pagodella ;* it has the shape, colour, and pearly substance of the first, and the flattened imperforate lip of the last ; it may, in fact, be called either a perlaceous *Pagodella* or an imperforate *Chlorostoma*. Having now gone through the genus *Trochus*, we proceed to the next, or sub-typical group.

(205.) On entering the genus MONODONTA, we must refer to what has been just said on the Oceanic † species of *Calliostoma*, the greater convexity of whose basal whorl cannot fail to have been remarked ; thus we are conducted to *Elenchus*, the first sub-genus of the present group, and found only in the same latitudes. These

* It is of these, we believe, that the genus *Margarita* has been proposed, to include such as have "the operculum of few whorls."

† The Continental naturalists employ this term to designate the productions of those countries or seas lying in the Great Pacific Ocean.

splendid shells, although mostly of a small size, have a brilliancy in the emerald green of their apertures, which is perfectly unrivalled in this family (*fig.*40.) like the *Calliostomæ*, the basal whorl is convex,—more so, indeed, than in any other of this genus, except that to which it leads; the spire is also generally more produced, and in one species (*a*) is so long that it resembles a small *Turritella*. It is among these shells that the most prevalent character of *Monodonta* appears. The base of the pillar in some forms an angle, and in others a small but very distinct tooth: their exterior is always smooth.* Next to these we place a small group of equally ventricose shells, to which we retain Lamarck's name of *Monodonta;* they have, in fact, almost the form of *Senecti*, but they are small, and the pillar is both umbilicated and toothed: in some, these characters are very slightly developed; in others, they are very strong; and this variation takes place in species otherwise so much alike, that they might almost be taken for the same at different periods of growth. They are mostly finely granulated, and sometimes striated within; but their ventricose aspect is altogether peculiar; the umbilicus is always smooth round its edges, but varies in its size. In the next sub-genus, *Fragella*, the basal tooth is so large, that its projection, joined with the teeth on the inner margin of the outer lip, gives the aperture an appearance of being distorted. The well-known little shell called the strawberry trochus, is the type; and, by its depressed form, pointed spire, and large umbilicus, reminds us immediately of a genuine *Trochus:* the surface of nearly all is beautifully granulated. In our fourth group, or *Monilea*, the umbilicus and its singular marginal rim are precisely the same as in *Chlorostoma*, except that the umbilicus is wider, the

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* This beautiful group was well known to Humphrey, whose name, imposed near forty years ago, we have of course retained, instead of some others recently given by the French nomenclators.

shape more depressed and trochiform, and the surface of the shell often granulated; the only remnant of the tooth is shown by one or two small tubercles or notches at the base of the outer lip. Several species, mostly of a small size, are now before us, all of which are natives of warm climates or of the Pacific Ocean. Lastly, we find in this genus, as well as in TROCHUS, one division which have not perlaceous shells, but which, possesses a well-defined tooth. These species we include under the name of *Echinella*. The most typical is that figured in the Ency. Méth. (pl. 417. fig. 6.) as *Monodonta coronaria*,—a shell which is a perfect prototype of our *Pagodella echinata*: the species yet known are few; but of these we possess the connecting link to *Elenchus*, in our *E. granulata*. We are thus brought back to *Elenchus*, where we commenced our survey of MONODONTA. The naturalist will not fail to perceive, that in thus resting our arrangement upon affinity, we have indicated strong relations of analogy between TROCHUS and MONODONTA: to these we shall presently return.

(206.) The two remaining genera, SOLARIUM and ONUSTUS, do not comprise more than a few recent species, although it is highly probable that many of the imperfectly preserved fossil discoid shells belong to the first, and some few also appertain to the last. On receding from the typical species of *Solarium*, the spire becomes more prominent, and the edge of the body-whorl dilated to form a sharp edge, so thin as easily to be broken off; the crenated margin of the umbilicus of these shells, however, indicates their affinity to the singular genus *Onustus*. From certain slight and irregular indentations on the preliminary whorls of the spire, we suspect that, at an early age, many of these animals gather small fragments, and fasten them upon their shells; but that, when older, these extraneous substances either fall off, or are voluntarily discharged; just as if the animal, having acquired its full powers by age, was able to fabricate its own habitation without calling in other assistance. Now, the same advance which we have thus stated as taking place

from *Solarium* to *Onustus* on one side, can also be discovered on the other side from *Canthorbis*. The gradation, in fact, is equally perfect on both sides: the two extremities of the column of the TROCHINÆ, commencing with the sub-umbilicated species of *Canthorbis*, and ending with the sharp-edged *Onustus*, meet together in the *Onustus agglutinans**, which thus closes the circle of the five genera of the TROCHINÆ.

(207.) The two aberrant types of this family are as remarkable for the paucity of their forms, as the typical TROCHINÆ are otherwise. Of the *Rotellinæ*, in fact, we can only enumerate two genera; and one of these not so effectually as we could wish. We think the *Turbo Nicobaricus* is the type of a sub-genus (*Chrysostoma* Sw.) much more related by its shell to *Rotella* than to *Senectus*, even if its operculum should prove to be shelly. It differs from all other *Trochidæ*, in having a very thick deposition of shelly matter spreading over the umbilicus, which it almost conceals: it does not, however, extend near so far as in *Rotella;* and yet both shells are evidently highly polished by their animals. On this account, therefore, and in the absence of all knowledge of the animal, we place it as the representative, among the *Rotellinæ*, of *Senectus* and *Monodonta*. Of the fossil genus PLEUROTOMARIA very little can be said: it obviously enters into our present family, from the trochiform shape of its shell; and the foregoing analysis renders its station in any other group highly improbable; we place it, therefore, between *Rotella* and *Phasianella*, as the type of a sub-family, the other members of which cannot now be distinctly ascertained. The truth is, that in this and numerous other instances, the study of fossil conchology is impeded by insurmountable difficulties, which must always exist. How many genera are in our systems, belonging to the older

* It is somewhat remarkable, that, from Lamarck's description of this shell, it would seem to have the umbilicus open when young, but closed when it has reached maturity. In two fine specimens now on the table, it is completely covered; and yet there is a fossil species from Hordwell, where it is perfectly open, although not large.

geological beds, which we only know from casts and mutilated fragments! and how many others, even in the newer formations, which it is impossible to arrange with precision, from ignorance of the animal! These are the true reasons which lead us to say as little as possible upon all those fossil genera whose affinities are doubtful; since, from the peculiar nature of the object we have in view, we would rather incur the imputation of overstrained caution, than the opposite extreme.

(208.) We have hitherto considered only the affinities of the *Trochidæ;* let us now turn to their analogies. Our first table will be of the primary divisions, or sub-families, which represent those of the *Turbidæ* in the following manner:—

Analogies of the Sub-families of the TROCHIDÆ *and the* TURBIDÆ.

Sub-families of *Trochidæ.* Typical Genera.	*Analogical Characters.*	Sub-families of the *Turbidæ.* Typical Genera.
SENECTUS.	(1. Sub-typical.) Shell globose; operculum shelly; spire short, obtuse, ventricose.	AMPULLARIA.
TROCHUS.	(2. Typical.) Spire pointed; whorls more numerous; operculum horny.	MELANIA.
ROTELLA.	(3. Aberrant.) Shell depressed; inner lip thickened.	THALLICERA.
PLEUROTOMARIA.	Trochiform; the outer lip with a marginal slit or sinus.	IANTHINA.
PHASIANELLA.	Spire greatly lengthened; operculum shelly.	TURRITELLA.

Whatever may be the rank of *Pleurotomaria,* it is certainly the prototype of *Ianthina.* These latter shells are so excessively brittle, that not one in five hundred are perfect; but the sinus, although neither so long nor so narrow as in *Pleurotomaria,* is nevertheless fully developed in the perfect shells, but more especially in our *I. globosa.** The long-spined *Turritellæ* represent *Phasianella,* and both have a shelly operculum. The other analogies are not so striking,— excepting, perhaps,

* Zool. Ill. 1st Series.

that of *Senectus* to *Ampullaria;* both being large globose shells, and the latter sometimes closed with a shelly operculum. The curious reader, who may be desirous of prosecuting these analogies further, may compare them, at his leisure, with many others in the volume.

(209.) We shall now bring together the genera of the two sub-families.

Analogies of the SENECTINÆ *and the* TROCHINÆ.

Genera of the SENECTINÆ.	*Analogical Characters.*	Genera of the TROCHINÆ.
SENECTUS.	Typical of their respective circles; volutions convex.	TROCHUS.
MARMAROSTOMA.	Sub-typical; umbilicus with a basal groove.	MONODONTA.
DELPHINULA.	Nearly discoid; umbilicus very deep; pillar none.	SCALARIA.
CYCLOCANTHA ?	Shell not perlaceous; trochiform.	ONUSTUS.
CIDARIS.	Aperture oblique; operculum shelly.	CANTHORBIS.

Our only doubt relates to what is the true type between *Delphinula* and *Cidaris*. It is either the shells we have before mentioned, or those of which *Turbo pagodus* is the type, where the operculum is horny. We may now turn to the

Analogies of the Sub-genera of CANTHORBIS.

Sub-genera of CANTHORBIS.	*Analogical Characters.*	Genera of the TROCHINÆ.
Tubicanthus.	Aperture obliquely round or oval; smooth.	CANTHORBIS.
Canthorbis.	Greatly depressed; the sides carinated; umbilicus small.	ONUSTUS.
Pyramidea.	Aperture thin, sharp, brittle.	SOLARIUM.
Lamprostoma.	Aperture strongly toothed or tuberculated; striated within.	MONODONTA.
Carinidea.	Aperture nearly entire, slightly angulated; smooth within.	TROCHUS.

The results of this table will explain why we have thought it expedient to characterise as sub-genera the types of such a small group as *Canthorbis;* for the shells it contains are so remarkably varied, that, without some

clue to the *meaning* of this variation, it might appear a questionable group. The only one of these analogies on which we have any doubts, is that between *Carinidea* and *Trochus:* we are, in fact, at a loss to know whether *Trochus Niloticus* and *Turbo Pica* are the real types of *Carinidea,* in which case they would open a passage from the large *Canthorbi* to the small and moderate-sized shells of our genus *Trochus:* the strong and unquestionable affinity, however, of *Carinidea concavus** to our sub-genus *Chlorostomus,* although the one is a large and the other a small shell, cannot be disturbed. But, on the other hand, even if the passage from *Canthorbis* to *Trochus* is made by *Niloticus* and *Pica,* the difference is one of very inferior moment. Two things are certain: one, that *Canthorbis* is the intermediate group, which connects the *Trochinæ* to the *Senectinæ;* the other, that it equally connects our genera *Trochus* and *Onustus:* for every conchologist will perceive that *Tubicanthus* runs into *Cidaris* by means of *C. rugosus* and *Cookii.* There is, however, another analogy belonging to *Canthorbis,* too remarkable to be passed over: it is, in its own group, what *Cerithium* is in the circle of the *Strombidæ:* this is shown in its twisted and outwardly-curved pillar, as well as the numerous volutions, and the consequent length of the spire. According to this view, *Pyramidea* and *Lamprostoma* would be the types,—since they are the most conical and elevated of all the others.

(210.) We now come to the sub-genera of the two typical groups, *Trochus* and *Monodonta.* It has been seen that each forms a circular group; and the preceding observations will, in some measure, have prepared the reader for the following general exposition of their sub-genera. The genus *Margarita* of Leach appears to us a purely artificial group, partly composed of our umbilicated *Trochi,* and of the true *Calliostomæ;* we have therefore not adopted it.

* Our specimen, fortunately, possesses its operculum, and has never been cleaned.

Analogies of the Sub-genera of TROCHUS *and* MONODONTA.

Sub-genera of TROCHUS.	*Analogical Characters.*	Sub-genera of MONODON.
Trochus.	More or less umbilicated, but the umbilicus always smooth.	*Monodonta.*
Trochidon.	Base of the pillar forming a prominent tooth.	*Fragella.*
Calliostoma.	Imperforate, smooth, or slightly granulated; basal whorl sometimes ventricose; spire long, pointed.	*Elenchus.*
Pagodella.	Shell not perlaceous, pyramidical.	*Echinella.*
Chlorostoma.	Deeply umbilicated; the inner lip thickened and truncate half way round the margin.	*Monilea.*

These analogical resemblances are so close, that, but for the former explanations, an incautious conchologist might easily mistake one for the other. Unfortunately, we are in total ignorance of the animals of all these, *Trochus* excepted. Whether they have each a peculiar modification of form, or whether Nature has confined herself to tracing out these variations by the shells alone, are questions which time alone will develope.

(211.) "A natural arrangement," as an eminent entomologist has more than once observed, "will stand any test." We have now placed it in the reader's power to act upon this hint, by applying all those "tests" which our preceding diagrams have supplied, to our arrangement of this family. There is one, however, which, from its singularity, may here be mentioned.

Analogies of the TROCHIDÆ *to the* ACHATINÆ.

Sub-families of TROCHIDÆ.	*Analogical Characters.*	Genera of the ACHATINÆ.
SENECTINÆ.	Ventricose; spire short; aperture always entire.	BULIMUS.
TROCHINÆ.	Spire conic, more developed; base of the pillar notched or toothed.	ACHATINA.
ROTELLINÆ.	Nearly discoid.	CYCLOSTOMA.
PLEUROTOMINÆ.	Outer lip, either above or below, with a slit.	HELICINA.
PHASIANELLINÆ.	Spire very much produced.	CLAUSILIA.

These analogies, of course, are much more remote than those we have been tracing, because the groups themselves are much more remote; and yet the same mode of variation is preserved in two different families — one marine, the other terrestrial. The *Rotellæ* in one, and the *Cyclostomæ* in the other, are the most discoid shells in their respective families; while, at the opposite side of the circle, we find the long-spired *Phasianellæ* representing the still longer-spired *Clausiliæ*. Some of the *Helicinæ* have a deep narrow slit at the base of their aperture, precisely similar to that on the outer lip in *Pleurotomaria;* and in both instances this structure is only a repetition of what is seen in *Ianthina, Scissurella,* and *Pleurotoma*. The two first analogies equally hold good, so that the two groups mutually test each other.

(212.) We have placed the *Trochidæ* next to the *Helicidæ,* under the belief that they followed each other, although the links of connection were wanting. It is clear, that of all the types of the TROCHIDÆ, *Rotella* is that which by its general form makes the nearest approach to *Helix;* while the thickening of the inner lip, which spreads over the umbilicus, is found also, but in a less degree, in many of the land volutes, *Lucerninæ*. But a singular discovery, recently made, has thrown an entirely new light upon this interesting question. Among a considerable number of freshwater *Planorbi,* all of one species, which were sent us from Brazil, we picked out two helix-looking shells, so precisely of the same olive brown colour, and of the same size, as the others, that none but a conchologist would have been led to examine them. They appeared, in fact, like two little land-snails of the sub-genus *Zonites,* that had fallen into the water where the *Planorbi* had been found, — their outside being discoloured, and covered with little particles of dirt and sand. On placing them, however, under the magnifier, a conchologist can alone judge of our astonishment at finding that the whole of the shell was actually composed of little stones and grains of sand only, agglutinated together, yet with so much skill, by the animal, that the

regular turns of the volutions of the spire, and the form of the umbilicus, was most accurately preserved: they were, in short, *freshwater* carriers — absolute counterparts of their marine brethren, *Onustus*. As we can find no notice, or even allusion, to such an extraordinary genus of shells in any writer, we have considered it new, and affixed to it the name of *Thelidomus*. In regard to its affinity, we suspect that it fills the same situation among the *Rotellinæ* which *Onustus* does among the *Trochinæ*: this will make it the most aberrant type, and consequently that which comes nearest to the *Helicidæ*, whose form it actually possesses. The annexed figures (*fig.* 41.) are taken from the only two specimens in our cabinet which we have either seen or heard of; the line denotes their natural size. Thus, there is ground for supposing that the passage from the marine *Trochidæ* to the terrestrial snails is marked by one or more fluviatile types, just as is the passage on the other side of the *Helicidæ*, marked by the *Limnacinæ*. The accidental discovery, also, of this extraordinary shell, will probably induce naturalists to a more accurate examination of the fossil turbinated univalves than they have received; for it is clear, that, although *Thelidomus* opens the path to the *Helicidæ*, there must be several other forms between the two, either extinct or undiscovered.

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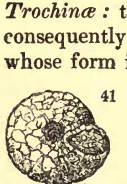


CHAP. VIII.

THE PHYTOPHAGOUS GASTROPODS CONCLUDED.—THE HALIOTIDÆ, OR EAR-SHELLS, AND THE NATICIDÆ, OR NERITS.

(213.) THE HALIOTIDÆ, or ear-shells, follow the *Trochidæ*, and, like them, in their typical examples, are of a rich pearly and iridescent substance. They have

been confounded, even by Cuvier, with the true *Scutibranchia*, merely because, like them and the *Tubulibranchia*, their mode of generation is the same. If this latter consideration is of such importance, all these three should form one group; and not only so, but they should be united to the *Dythera*, or bivalves,—since they also are fecundated in a similar manner. The fact, however, appears to come out, by analysis, that the *Haliotidæ* are the representatives of the limpets (*Scutibranchia*) in the great circle of the phytophagous gastropods, just as the naked dorises (*Nudibranchia*) represent the limpets (*Scutibranchia*) in the entire class of shell-fish (*Testacea*). And thus, no less a naturalist than Cuvier, from not attending to the two sorts of relationships,— analogy and affinity,—has mistaken the one for the other in both instances, and obscured one of the most beautiful transitions in nature. To this most accurate anatomist, however, we are indebted for the first knowledge of the animal of *Haliotis*, and to M. Quoy for that of *Stomatia*.* Without entering into the details, we may simply state that the structure of the first evinces an analogy to that of the *Patellidæ*, or limpets; while the animal of *Stomatia* still more closely resembles that of the *Trochidæ*, and more especially of *Phasianella* and *Cidaris*. The determination of these two facts are of the highest importance, since it enables us to discern the two typical groups; while a beautiful delineation of the *S. Chinensis*, among the unpublished drawings of Guilding, and of the animal of a *Sigaretus* by M. Quoy, makes us actually acquainted with the inhabitants of four out of the five genera which compose the family.

(214.) In regard to the shells of the *Haliotidæ*, they are easily and certainly recognised: they may be called, indeed, turbinated or spiral limpets, inasmuch as nearly the whole have some slight developement of a spire; but an indication of the pillar is only seen in that genus which comes nearest to the *Trochidæ*,—namely, *Calyp-*

* *Stomatella tachettée*, Voy. d'Astrolabe, pl. 66. *bis.*

*træa.** The whole may, therefore, be characterised as patelliform shells, always possessing either a small spire of two or more volutions, or some internal support within, although the pillar is wanting. They are, in fact, the discoid type of the phytophagous *Gasteropoda;* representing on one side the testaceous *Cephalopoda,* and on the other the *Scutibranchia,* or limpets. Like the *Volutidæ,* they have no operculum, and both represent each other in the extreme shortness of their spire. In comparison to those we have already noticed, this is a very small family,—so small, indeed, that its primary divisions are only of the rank of genera. They are, in a manner, fixed or sedentary shell-fish; for, although some are capable of locomotion, they must move but very little, since the obvious construction of their shells† is manifestly for the purpose of adhesion. Hence they are found closely affixed to rocks or other substances near or within the sea. The round holes in the perforated ear-shells (many species of which are of a large size and splendidly iridescent) are for the passage of slender filaments which the animal can protrude at pleasure: these, of course, do not exist in those ear-shells which are without perforations; but in both the mantle of the animal is highly ornamented,—being in *Stomatia* regularly cut into numerous points, like the teeth of a saw; and these, in *Haliotis,* assume the more lengthened shape of filaments. Both these, which constitute the two typical genera, enjoy the free power of locomotion, for we do not observe that the contour of the shell of individuals of the same species ever varies,—a clear proof that they never take the form of that substance they may happen to be attached to. In *Calyptræa* and *Crepidula,* however, the case is different. We have no doubt that the greater part, at least, of these shell-fish

* Cuvier, indeed, admits these and similar patelliform shells approximate in their animals to the *Trochidæ,* and yet he places them widely apart from *Stomatia,* whose structure in its soft parts is still more like that of *Trochus.*

† Except, of course, *Sigaretus,* which has its shell enveloped on its back, as representing the *Tectibranchia.*

live and die on the very spot where they were originally born; for the circumference of almost every individual presents a different contour, according to the surface of the substance on which it adhered. Like the *Trochidæ*, we find that the two typical divisions alone are perlaceous. One species of *Haliotis* is found on our south-western coasts; but the greater part of these splendid shells, as well as *Stomatia*, come from warm latitudes.

(215.) The five primary divisions of the family are only genera,—*Haliotis* and *Stomatia* being the most typical; then follow *Calyptræa*, *Sigaretus*, and *Crepidula*. The whole of these constitute a circular group, connected by the third type to the *Trochidæ*, and by the fifth to the *Neritidæ* by means of *Navicella*. The scientific reader will find all these groups sufficiently characterised in our arrangement; but a few general remarks appear called for in this place. It is singular that, if any modification in the structure of the animals in *Haliotis* exist, they are not conspicuously* shown in these shells, with the exception of one, the *Haliotis asinina*, or ass's ear; while in *Stomatia* (of which Quoy has figured the animal of the typical species), the variations in the shell are so many, that there can be little doubt of their being accompanied by a corresponding variation in their animals. As we are somewhat undecided whether these should all receive subgeneric names (as in the instance of *Stomatella*), we shall here only mention what appear to be the five types.† *S. planulata* obviously unites *Stomatella* to *Haliotis*, by means of its prototype *H. asinina*. In both, the spire is very short, the form oblong, and the outer surface smooth. *S. auricula* seems to be the next type, where the spire is sufficiently developed to be elevated above the surface of the body-whorl; then comes the

* Perhaps, however, conchologists have paid too little attention to the *Haliotis* in the variations of their form.

† It is curious that Mr. Sowerby, unaware of our views, should have hit upon all these, and urged this variation as a reason for not adopting Lamarck's *Stomatella*: see his *Genera of Shells*.

typical form in *Stomatia imbricata* and *sulcifera*, which appear to have from two to three distinct spiral whorls*, but still without any ridges or angles, although the outer surface is finely imbricated. In *duplicata* the spire is still more developed, angulated, and marked with granulated tubercles; so that, in fact, it much more resembles one of the *Senectinæ*, and particularly *Cidaris*, than a *Stomatia*, while its angulated shape and tubercles remind us of *Delphinula*. Lastly, we have a form, in *S. phimotis*, very distinct from all these: the spire is again shorter, more like that of *planulata* and *auricula*, but it is irregularly formed; the outside of the shell is rough and angulated, as in *duplicata*, so that it unites the form of all these three; we have an indistinct recollection, also, that the substance of this shell is not perlaceous, like all the preceding species. Now, the reader, if he turns to our distribution of the *Trochidæ*, and of the types therein contained, cannot fail to be struck with the singular coincidence of these five species agreeing with the variations there pointed out. This will be seen more clearly by throwing them into a tabular form.

Analogies of the Types of STOMATIA.

Types of STOMATIA.	*Analogies.*	TROCHIDÆ. Types.
S. planulata.	Spire flattened; outer surface smooth.	*Rotella*, Cidaris.
phimotis, or *obscurata* Lam.	Shell and spire irregular; substance not perlaceous; outer surface rough, carinated.	*Onustus.*
duplicata.	Spire elevated; the whorls angulated and coronated.	*Delphinula*, Canthorbis.
Auricula.	Spire short, raised above the body-whorl; perlaceous.	*Senectus.*
imbricata.	Spire more elevated and developed, but without any angles or tubercles.	*Trochus.*

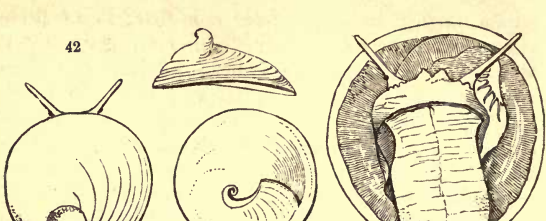
We are unacquainted with any of the fossil species, but we have no doubt, after this exposition, that they

* Sowerby's Genera, art. *Stomatia*, figs. 1 and 2.

will arrange themselves under one or other of these types. Without enlarging further upon these analogies, we may briefly state that they are in perfect uniformity with that principle of variation which runs through the whole of the animal kingdom. It was long ago announced by one of the most philosophic naturalists of the age, that when Nature, so to speak, is about entering a large assemblage, she gives, as it were, in the onset, a sketch of the five leading forms she intends to adhere to, although under innumerable modifications. Thus, in the class of ACRITA, as MacLeay observes, she typifies the five great classes of animals; and thus again, in the very first group of the spiral univalves, she presents us with indications of the five great families of the phytophagous and zoophagous *Gasteropoda*, all concentrated in the limits of a single genus.

(216.) The station of Lamarck's genus CALYPTRÆA is fully determined by the structure of his *Stomatella duplicata*, since both form an obvious passage to the *Trochidæ*, by showing the first developement of a central pillar. Lamarck's observations upon this interesting group, which contains many natural subgenera, appear to us characteristic of that accurate perception, almost intuitive, of natural affinities and relations which characterised all his writings before his unfortunate blindness, — a rare talent of discrimination, which, as it has been justly observed by others, places him, in this respect, far above even the author of the *Règne Animal*. Although he had not the advantage of being acquainted with the animal, made known to us by the unpublished drawings of Guilding* (of which the annexed cut is a copy, *fig.* 42.), he considered this genus, not related (by affinity) to *Patella*, but that its incipient spire and pillar indicated a structure approaching to that of *Trochus*. He erred, apparently, in carrying this theory too far, by supposing

* The typical form is probably *C. Chinensis*, the species here figured.



that his *C. trochiformis* would be better placed in that family. But even the errors of such a man are as lights to others; for when doubts exist as to the limits of a genus, we may be perfectly sure of the passage, and that both genera are natural. On the other hand, if we look to the resemblance between *Patella* and *Calyptræa* as *analogical*, these conflicting opinions are at once reconciled: both are cup-shaped, pyramidical, and with the apex almost central; and that both stand opposite to each other in their respective circles, the intelligent reader will perceive if he brings these families into comparison.

(217.) The next group, which, from a consideration of the animal, we have here named CHELINOTUS, corresponds, in some measure, to *Sigaretus* of authors. We find it impossible, however, to understand this group. It has been customary to place in *Sigaretus* nearly all those ear-shaped shells of the same form as *Stomatia*, but which are not perlaceous, without a knowledge of their animals, or, even when that was obtained, without a due regard to the differences they exhibited. We mention this, not as conveying censure, but as the probable reason why we cannot unravel this exceedingly intricate question. This has partly arisen, strange as it may appear, from the new light thrown upon the *Naticæ* by Guilding. The beautiful delineations he has made of the animal of a typical species, shows that it is almost an internal shell, or at least

so far as that its circumference is fitted into a fleshy rim. The aspect of Quoy's *Cryptostoma* again, and of Blainville's, are much the same; and neither of these agree with the delineation of the animals of De Blainville's *Sigaretus*, *Vetulina*, or *Coriocella*. In the present difficulties, in short, which surround this question, we shall leave it for the investigation of others: our impression is, that part of the *Sigareti* of authors belong to the *Naticidæ*, and part to this group; and that these can only be determined by the structure of their animals. In the meantime we have no great hesitation in considering De Blainville's *Coriocella* and *Velutina*, in conjunction with Quoy's *Sigaret de Tonga*, as sub-genera of that genus which intervenes between *Calyptræa* and *Crepidula*, and which we provisionally call CHELINOTUS, from the resemblance which the typical forms bear to the back of the tortoise. The animals of all these have two short, thick, cylindrical tentacula; the eyes being at their base, and either sessile, as in *Coriocella*, or at the tip of short peduncles (which are united to the tentacula), as in *Chelinotus*.* We believe, also (judging only from his figure), that De Blainville's *Sigaretus convexus*† belongs also to this group, since the animal merely differs from the *Coriocella* and *Chelinotus* in not having the anterior part of its mantle forked, and being very little larger than its shell, which thus becomes external. As for the shells themselves of these genera, they seem to be all of one form, precisely like that of *Vitrina*, which they obviously represent: hence they are not of primary importance in determining the question. As for the *Sigareti* of Lamarck, Sowerby, &c., we suspect that when their animals become known, they will turn out to belong to the *Naticidæ*, since, so far as the shells are concerned, we have a most perfect series by which they seem to be connected with the *Natica mamilla* of authors; while *Cryptostoma* may possibly be the tectibranchian type of that family, just

* *Sigaret de Tonga*, Quoy, Voy. d'Astrolabe, pl. 66. *bis*, figs. 4—8.
† Manuel, pl. xlii. fig. 2. 2 a.

as *Chelinotus* is of this: such, at least, are our present impressions on the relations of these perplexing forms. Our object, in all cases where we cannot analyse, is to state difficulties, not to smooth them. The present instance is one of the few groups we are compelled, from this cause, to leave in uncertitude. The reader will remember that the same difficulty has occurred in regarding the *Bullæ*. Now, both of these are analogous groups, and, with the *Naticæ, are all representatives* of the naked order TECTIBRANCHIA. This will be apparent on looking to the opposite columns, the contents of which follow each other perpendicularly, while the analogies are expressed horizontally.

(218.) A chapter would be scarcely sufficient for the full explanation of the innumerable relations implied in this table; we must therefore confine our attention to that line which contains the analogical representations of the *Tectibranchia*. All these turn out to be slug-like animals, with shells either larger than their bodies, or more or less capable of being concealed by the mantle: they are all free, that is, they have the full power of locomotion; their shells have few, if any, voluties; of a thin and delicate substance in most, but rarely sculptured; never rough, and generally smooth and polished. But what, perhaps, is the most remarkable feature running through the majority, is the striking resemblance they bear to tortoises, not merely in the oval depressed form, and often coriaceous covering of their back, but that this part should often be divided into angular or hexagonal plates, precisely analogous to those reptiles. Hence the expressive name of *Chelisoma*, given by Mr. Broderip to the type which represents the *Cyclobranchia*, while the back of our *Chelinotus* seems as if it was entirely covered with a shell divided into regular series of hexagonal plates. Even the shells, if such they may be called, of the typical *Tectibranchia* (as *Aplysia*, &c.) resemble the thin horny layers on those of tortoises; while the *Bullæ*, if they really belong to the *Cypræa*, so perfectly resemble these sea-slugs, that

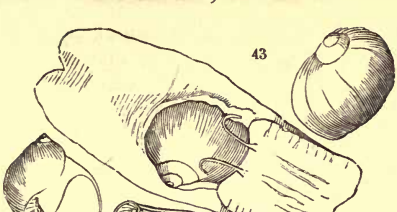
Analogies of the Order TECTIBRANCHIA.

Orders of the TESTACEA.	Tribes of the GASTEROPODA.	Tribes of the DITHYRA.	Families of the ZOOPHAGA.	Families of the PHYTOPHAGA.	Sub-families of the HELICIDÆ.	Genera of HALIOTIDÆ.
GASTEROPODA.	ZOOPHAGA.	MACROTRACHIA.	TURBINELLIDÆ.	*Trochidæ.*	HELICINÆ.	*Haliotis.*
DITHYRA.	PHYTOPHAGA.	ATRACHIA.	MURICIDÆ.	*Helicidæ.*	ACHATINÆ.	*Stomatia.*
NUDIBRANCHIA.	SCUTIBRANCHIA.	TUBULIBRANCHIA.	STROMBIDÆ.	*Turbidæ.*	LYMNIANÆ.	*Calyptræa.*
PARENCHYMATA.	CYCLOBRANCHIA.	CHELISOMA.	CYPRÆIDÆ.	*Naticidæ.*	LIMACINÆ.	*Chelinotus.*
CEPHALOPODA.	TECTIBRANCHIA.	BRANCHIOPODA.	VOLUTIDÆ.	*Haliotidæ.*	LUCERNINÆ.	*Crepidula.*

we know not, at present, the limits between the two. We could extend these analogies into the vertebrated animals; for they are not only manifested among the reptiles by the *Chelonides* or turtles, but by the armadillos, in the order of ruminating quadrupeds, the *Cassidæ*, or tortoise beetles, among the coleopterous insects; and, in short, throughout the whole animal kingdom.

(219.) Leaving, therefore, the true affinities of the *Sigareti* of authors undetermined, we may proceed to the genus *Crepidula* as the last we place in the present family. We know not by what form, if any, it is connected to *Chelinotus*, but its affinity on one side to *Navicella*, and consequently to the nerits, has been long admitted; while to *Haliotis* it is as obviously connected by means of *Crep. aculeata*, and such other ear-shaped species as have defined spiral whorls placed on one side of the shell, as in the *Haliotidæ*. Hence it follows that *Crepidula* stands at one side of the circle of the *Haliotidæ*, connecting them with the *Naticidæ*, and *Calyptræa* at the other, connecting them with the *Trochidæ*; it follows, therefore, that they cannot be united by affinity, except indeed on our theory, that the three aberrant groups always form a circle of their own.

(220.) Our fifth and last family is that of the *Naticidæ*, or nerits, consisting of those genera whose inhabitants are not furnished, like the *Turbidæ*, with a proboscis-formed mouth, and eyes placed upon their antennæ, but whose mouth is like that of the generality of shell-fish belonging to this tribe, and whose eyes, where they exist, are at the base of their tentacula. The animal of one of the typical *Naticidæ* has been beautifully drawn by Guilding, and is here copied (*fig.* 43.); it is a most extraordinary looking creature. The whole family differs from the *Trochidæ*, moreover, in having no lateral filaments; and in the form of their lips, eyes, &c.; and from the *Haliotidæ*, in all that respects the animals, as well as their shell. For reasons, however, which we have just before this detailed, this is the only family whose analysis we find it impossible to complete: this originates in the



incertitude regarding the many earlike shells belonging or related to the genus *Sigaretus* of authors, but of whose animals we know little or nothing. The reader will, therefore, understand that the only groups we consider to be natural in the following arrangement, are those of the *Neritinæ* and the *Naticinæ;* the three others being merely conjectural. If the animal of Cuvier's *Sigaretus* is like that of De Blainville's, we should thus refer it to the group which contains *Chelinotus ;* but we strongly suspect that the shells of the *Sigareti* figured by Sowerby* all belong to, and form the typical group of, the present family: Lamarck's *Natica* constitutes the second; and the Linnæan nerits the third: the other two may probably be represented by the *Cryptostomæ* of Blainville and Quoy; and the fifth, which forms the passage to the *Turbidæ,* either by *Lacuna,* Turton, or more probably by such long-spired types as *Truncatella,* Lowe. Of all these, as shells, it may be said generally, that they are globose and turbinate; the spire being always very slightly developed, the aperture large and semilunar, and the operculum, where it exists, either shelly or horny. They are moderate-sized shells, mostly marine, and are never perlaceous. In the *Neritinæ,* which approach nearest to the *Haliotidæ,* the spire is sometimes nearly or quite obsolete; but in the *Naticinæ* it is more developed and ventricose. The *Neritinæ,* by the teeth on their pillar, and excessively short spire, represent the *Volutidæ;* and *Cryptostoma,* the *Limacinæ,* or terrestrial slugs. What

* Genera of Shells.

the shells of these latter really are, we know not; but we have two, very thin and hardly opaque, which, judging from his figures, we suspect are of Quoy's *Cryptostoma:* they are as brittle as those of *Vitrina*, but are of that semitransparent whiteness which shows they must be internal shells, and they have no sculpture whatever. As to the *Sigaretus cancellatus* of Lamarck, it is manifest nothing can be advanced beyond mere conjecture until the animal is known. Of all these, therefore, the *Naticinæ* and the *Neritinæ* are the only sub-families which can safely be relied upon as unquestionable; yet even their genera cannot be demonstrated with that precision that could be wished.

(221.) The intimate connection between this family and the *Turbidæ* is too evident to require any demonstration. Thus, then, do we return to the latter group, and the great circle of the phytophagous *Gasteropoda* is rendered complete. On looking to its component parts or families, and to those of the zoophagous or carnivorous tribe, we find them representing each other in this manner:—

Analogies of the PHYTOPHAGOUS *and* CARNIVOROUS GASTEROPODA.

Families of the PHYTOPHAGA.	*Analogies.*	Families of the ZOOPHAGA.
HELICIDÆ.	Typical of their respective tribes.	MURICIDÆ.
TROCHIDÆ.	Sub-typical.	TURBINELLIDÆ.
HALIOTIDÆ.	Tentacula very short, sessile; shell with the body-whorl excessively large; the spire very short, and scarcely raised.	VOLUTIDÆ.
NATICIDÆ.	Animal, when crawling, larger than its shell, which is smooth, and generally polished; spire nearly or quite obsolete.	CYPRÆIDÆ.
TURBIDIDÆ.	Animal with a proboscis-formed mouth, and a respiratory siphon; eyes placed on the sides of the tentacula.	STROMBIDÆ.

There is every reason to suppose, from the three last analogies, that the two first will rest also upon the structure of the animals, and not upon their shells; but it unluckily happens we are totally ignorant of that inhabiting

the typical *Turbinellidæ*, so that it is impossible to determine what are its relations to the *Trochidæ*. In the present state of malacology, our only surprise should be that so much may be effected, and so many land-marks planted, with such very scanty materials.

CHAP. IX.

ON THE ABERRANT TRIBES OF THE GASTEROPODA,—NAMELY, THE SCUTIBRANCHIA, OR LIMPETS; THE CYCLOBRANCHIA, OR CHITONS; AND THE PTEROPODA, OR CRYSTAL-SHELLS.

(222.) The immense superiority in extent and multiplicity of types, which the phytophagous and carnivorous gastropods possess over all the other *Testacea*, not to mention the superior interest attached to them by conchologists and collectors, have induced us to devote the greater part of our volume to their illustration. Our space being limited, we have therefore no other resource but to abridge our remaining survey as much as possible.

(223.) The first of our aberrant tribes is composed of the Scutibranchia, or limpets; in extent, it is little larger than one of the least families of the spiral shell-fish: they may be almost termed sedentary or fixed; for although some have the power of locomotion, it is so limited that their shell often assumes the contour of the spot where they have remained. In the arrangement of their branchia, and the form of their bodies, they may almost be called testaceous *Doridæ*, at least so far as the typical species are concerned. The passage to this tribe, from the *Haliotidæ*, or ear-shells, is rendered perfectly easy and natural, whether we regard the want of a spire in *Crepidula* or the patelliform shape of *Calyptræa*. We have now arrived at the last division of univalve shells, where the structure is so simple that the shelly part of these

animals merely consists of a cup-shaped protection, without the least vestige of a spire, a whorl, or any internal support. The peculiarities of the animals have already been stated, and as those of the shells will be subsequently defined, we may at once proceed to a short statement of their relations and analogies. The whole are constituted of the following divisions, which may be termed genera. 1. *Fissurella*, having an oval perforation on the apex or summit of the shell. 2. *Emarginula*, where the perforation is a narrow slit. 3. *Hipponyx*, with the shell entire, but reposing on a spurious flattened valve. 4. *Pedicularia*, an entirely new genus. And, 5. *Patella*, having a simple cup-shaped shell, without any aperture or basal support. The three last are sedentary, and constitute the aberrant genera, the two former being the typical. A very rapid survey of these groups is all that we can give to them.

(224.) The genus FISSURELLA has the perforation on the top of the shell very much resembling a keyhole. This aperture is for the purposes of respiration, as the water thus communicates to the branchial cavity, which is placed, something like that of *Doris*, on the fore part of the back. The eyes, the mouth, and tentacula are very like those of the *Haliotidæ;* and the margin of the foot is also edged with short filaments. The shell, according to Cuvier and Lesson, is placed in the middle of the back, but does not cover it; so that we can scarcely suppose it is fixed to rocks, like the limpets. The muscular impressions in some of these shells, joined to their outward differences, intimate the existence of sub-genera, some of which we have ventured to characterise; we should not, perhaps, have done this, as the species are so few, had not most of those in the adjoining genus been already named.

(225.) The EMARGINULÆ, from the very slight notice given of them by Cuvier, do not appear to differ more in their animal, than in their shell, from the last. This difference, however, is quite sufficient to constitute them a genus. The aperture in the shell (which is more

conic) is not oval, but forms a very narrow slit or cleft, the position of which indicates the particular situation of the branchial cavity. In the typical species, this slit is at the base; in the sub-genus *Cemaria* Leach, it is in the apex; while in *Rimula* it is central between the apex and the margin. The most aberrant type is *Parmophorus*, where, as in all the tectibranchial types, the animal is much larger than the shell, which thus becomes partly internal; hence there is only a slight emargination on the margin. Our new sub-genus *Hemitoma* opens the passage between this and *Emarginula*; and thus the whole form a circle. The animal, like that of *Fissurella*, has the margin of the foot fringed with filaments, and the eyes pedunculated, but at the base of the tentacula. Cuvier says the mantle envelopes and covers a great part of the shell; and this is shown by Rüppell to be the case also in *Parmophorus*, but to a greater extent.

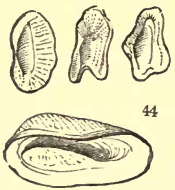
(226.) Hipponyx is one of the most remarkable of the patelliform shells: it is cup-shaped, like *Emarginula*, but has no fissure: it may be almost termed a bivalve, since it forms a flat, thin, calcareous plate, which covers that part of the rock on which the upper valve, or true shell, reposes; this latter so much resembles a limpet, that it can only be known by its horseshoe muscular impression: the common species are small, and generally whitish. The animal figured by Mr. Quoy has the mouth shaped like a short proboscis, totally different from that of the *Trochidæ*, near to which some authors approximate it; the mantle is not fringed, and the eyes and tentacula are like those of *Emarginula*. Several recent species from warm countries are now known, and a few fossil ones. The sub-genus *Capulis*, which has not this basal valve, seems to connect *Hipponyx* with *Emarginula*, — which latter it resembles in the cup-shaped form of its shell. The analogy of this genus, in their shells, to the bivalve *Branchiopoda*, is particularly remarkable.

(227.) The genus Patella stands at the opposite

side of the circle we are now tracing, and consists of all those simple cup-shaped shells which have a defined apex or top, but without any basal or internal support. They adhere to rocks, and by their broad and fleshy foot retain such a firm hold as not to be separated without great art or violence. The animal very much resembles that of *Hipponyx;* for Cuvier says it has a short and thick snout, two distinct and pointed tentacula, and the eyes placed at the base. The most important sub-genus yet determined is *Siphonaria* Sow., which, with that inconsistency and violation of all natural affinities which pervades the greater part of this class, as exhibited in the *Règne Animal*, is actually placed in a different order, between *Calyptræa* and *Sigaretus!* Every one accustomed to contemplate the beautiful order and gradation of nature, must be shocked at such a violation of natural affinity as this arrangement exhibits. It is the more inexcusable, because it is neither sanctioned by any resemblance whatever between the shells or their animals of the genera thus confusedly mixed. *Siphonaria*, in short, is that link which connects the *Scutibranchia* with the *Cyclobranchia;* for, like these latter, according to Cuvier's own showing, "the tentacula seem to be wanting, the head being merely furnished with a narrow veil;" so that, if these organs really exist, they must be but mere vestiges. Here, then, is probably the last form of the *Scutibranchia;* and it occurs exactly at that point of the circle which, from theory, could be next to the *Cyclobranchia.*

(228.) But there is yet another form to be added: this is our new genus PEDICULARIA (*fig.* 44.), which appears never to have been described by any writer. In its somewhat patelliform shape it resembles a *Patella;* yet, although always oval, its form is irregular, since its circumference is adapted to the inequalities of the substance to which the animal adheres: hence, to an inexperienced eye, the margin would appear broken: its substance, however, is strong, like that of a *Hipponyx*, from which and from *Patella* it essentially

differs in having a callous prominent rim placed longitudinally on one side only of the inner surface, and to which the principal muscle is probably attached: there is no regular apex, but merely a rudimentary indication of one,—one side of the shell being more gibbous than the other; so that, if this faint indication of a volution had formed an apex, it would have been longitudinal, or on the lateral sides of the shell,—and not central, as in *Patella*. The annexed figures will illustrate this description, and show the irregularity of form in one and the same species. We found all these adhering to coral fished up on the coast of Sicily, so far back as 1807; and a few specimens, if we mistake not, were given to our friend Dr. Leach, for the British Museum. It is perfectly analogous to the parasitic genus *Coccus* among insects; and, indeed, much more resembles them, or the internal shell of some unknown tectibranchian mollusk, than any thing else. An approximation is made to this genus by certain small limpets, whose apex, from being lateral, makes them also inequilateral shells: of course, we know nothing of the animal; but, from the nature of the shell, it must be perfectly sedentary, as it embraced the coral most closely.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(229.) The CYCLOBRANCHIA, or *Chitones*, are known at once by their shells. They differ from all the gastropods yet noticed *, in being quite destitute of tentacula, — these organs being supplied by a membranaceous veil round the mouth: the mantle, also, unlike that of the *Patellæ*, is always exposed, and forms the circumference of that part by which the animal adheres: it is therefore externally coriaceous, and is covered for its protection by minute scales resembling shagreen, and often with spines or setaceous hairs; and on *each* side, underneath, are the lamellar branchia: this arrangement of the organs of breathing gives the name to the tribe. The

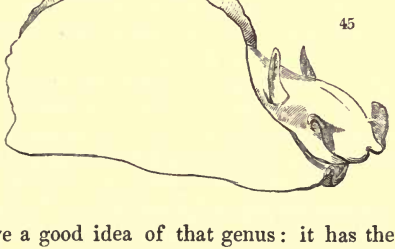
* Except *Herpa* among the *Limacinæ*, which is the cyclobranchian type of the *Helicidæ*.

testaceous part of the animal consists of a row of symmetrical scales, generally imbricate, or reposing on each other transversely along the middle of the back; but sometimes, as in *Chitonellus*, these valves are widely separated. The only naturalist who has effectually investigated these shell-fish, is our late regretted friend Guilding; and to his admirable paper upon them, we are indebted both for their natural arrangement, and the following notes on their manners when living:—"These animals frequent the rocks and stones of the sea coast, and are distributed nearly over the whole globe. Many species are constantly under water; while others ascend even above high water mark, spending the day exposed to the hottest sun, or resting in spots occasionally moistened by the rude and restless surf. In *Chitonellus* and *Cryptoconchus*, there are certain minute organs on the zone, which bear a strong resemblance to the spiracula of annulose animals. They seem to feed entirely by night. Though they remain stationary during the day, yet when disturbed they will often creep away with a slow and equal pace; sometimes sliding sideways, and creeping under rocks or stones for concealment. If accidentally reversed, they soon recover their position by violently contorting and undulating; and for defence, they sometimes roll themselves up, like the woodlice."* Although only two or three small species are found in Europe, there are numerous large ones from the tropical latitudes, particularly the coasts of Chili and Peru.

(230.) The TECTIBRANCHIA constitute the last group in our arrangement of the *Gasteropoda*. In it we include all those naked testaceous mollusks, whose shell, when it exists, is either rudimentary or partly concealed by the lobes of the mantle; and whose branchia, in the form of leaves, are arranged either on one or both sides of the body, or on the back, but in all cases concealed or covered either by the edge of the mantle or by a thin shell. We do not think that these animals

* Zoological Journal, v. 29.

have any degree of affinity with the *Nudibranchia*, whose gills are invariably exposed, and arranged symmetrically. All are marine, and crawl on their belly; but the major part, from having the lobes of the mantle dilated, are likewise capable of swimming. Nevertheless, they are thick, unsightly creatures,—resembling, when caught, shapeless lumps of flesh; for the tentacula, where they exist, are short; the shell (if present) is hid in the mantle; and it is difficult to know, at first, at which extremity the head is placed. They cannot be preserved effectually in spirits; but by being placed in sea water, when first caught, they soon begin to crawl, and exhibit their true form. The annexed sketch of our *Aplysia Sicula* (*fig.* 45.), taken from the living animal,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will give a good idea of that genus: it has the power, like many other species, of emitting a copious black or purple fluid when caught, like some of their prototypes the *Cephalopoda*, for the purpose of discolouring the water, and eluding their enemies.

(231.) The TECTIBRANCHIA, even from the little yet known of them, appear to form a most natural group, in which the circular succession of the five types, and the analogies they bear to the conterminous tribes, may be distinctly traced. The variation in the form and position of the branchia, although quite insufficient to remove the aberrant types from *Aplysia*, is yet of much importance in determining the primary divisions. Thus, in the *Bullinæ* and the *Aplysianæ*, the

gills are on the back, with long pectinations on one side: in the first they are covered by an oviform shell, and in the latter by a convex plate, resembling half a bivalve. In the three aberrant divisions, however, the branchia are lateral. *Phyllidea* has them on both sides; *Pleurobranchus* and *Gasteropteron*, on the right only; and, as Cuvier says that this latter genus "appears to be an *Akera* with the foot developed into broad wings," we consequently return again to the *Bullinæ*. If we look, on the other hand, to the presence or absence of the testaceous covering, the same circular course of the groups can be demonstrated. The pre-eminent type, seen in the genus *Bulla*, has the shell so perfect as sometimes to be capable of receiving the greater part of the animal, and it is always more or less convolute. In the sea hares or *Aphysianæ*, however, it is a mere rudiment, like one half of a bivalve shell; while in the three aberrant types, even this vestige is totally wanting. Some of Cuvier's genus *Akera*, he observes, have no shell whatever, or only a vestige of one, yet with the mantle of *Bulla*; and as he insists, in another place, on this genus being the closest to *Gasteropteron*, we come to the same results as by studying the variation of the branchia. The *argumentum ad verecundiam* may thus be advantageously employed, though we generally prefer resting our theory on the simple facts brought before the reader.

(232.) And yet, although there is evidently a circular disposition among the *Tectibranchia*, and a strong affinity to the *Cyclobranchia* on one side, and to the *Pteropoda* on the other, their affinity with the *Gasteropoda* is not so evident,—at least, if we consider the *Bullæ* as standing at the head of the tribe. This point, however, cannot be well decided, until we know the animals of such shells as *Bulla naucum*, *Aplustra pulchella**, &c. There can be no doubt, that between an animal which can recede entirely within its shell, and one which envelopes it (as *Akera*, &c.), there must be many

* *Bulla aplustre* Linn.

essential differences. Lamarck has judiciously separated these into two groups, to the first only of which he retains the old name of *Bulla:* some of these may, possibly, be connected to the aberrant *Volutidæ;* while others, by uniting with *Akera,* will open a passage to the *Cephalapoda* by means of *Gasteropteron.* At all events, the situation of the TECTIBRANCHIA is clearly intermediate between the GASTEROPODA and the CEPHALOPODA.

(233.) The PHYLLIDINÆ, as Lamarck has already shown, evidently connects the *Cyclobranchia* to the *Aplysia,* or sea-hares; hence its general form is that of a *Chiton,* being oblong oval, but without any testaceous covering. The mantle does not appear divided, but covers the back like a shell, and is usually of a strong coriaceous substance: there are two small tentacula, shaped as in *Doris,* on the upper surface; and two others, still smaller, beneath, on the sides of the mouth, which Cuvier says "is a small proboscis;" but this does not appear in Rüppell's figure of *P. pustulosa**, which was taken from the life. The branchia are in the form of two long leaves or pectinated processes, placed on each side of the body, under the edge of the mantle, for its whole length. The *anus* is on the hind part, and the genital orifice forward, under the right side. In the sub-genus *Diphyllidea,* the branchia are the same; but the anterior part is more narrowed, and the second pair of tentacula are reduced to tubercles. These animals are not numerous, and are almost confined to the Eastern Ocean.

(234.) In *Aplysia* †, the typical characters already mentioned begin to appear. These animals have the appearance of a neck. The upper tentacula are shaped exactly like those of a hare, whence the common name of *Sea-hares,* given to these animals in most countries

* Rüppell, Atlas i. pl. 11. fig. 1.

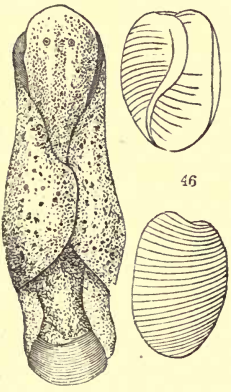
† A very costly work by M. Sander Rang and De Férussac on this group has been published; but, as it is out of the reach of ordinary naturalists, we do not possess it, and therefore cannot consult it. This is one out of the numerous evils of these *ouvrages de luxe.*

by the fishermen. The head and lips are much like those of a slug; and the lower tentacula, which are flattened, are small, and placed on the edge of the lower lip, while the eyes are situated above them; the branchia are composed of complicated lamellæ, placed on the back, but covered by a small membraneous mantle, in which is a thin, convex, and horny plate, hardly to be called a shell, since it more resembles an operculum. The edges of the foot, which is enormous, forms around it a prominent margin or crest, so dilated that they can be thrown over the back, just like the mantle of the cowries and the *Bullæ*; and with these processes the animal occasionally swims. "An enormous membraneous crop," observes Cuvier, "leads to a muscular gizzard, armed internally with cartilaginous and pyramidical processes, which is followed by a third stomach, provided with sharp hooks; and this again by a fourth, in the form of a *cæcum*." These animals appear to feed only on sea-weed, and are oviparous. Such are the characters of the typical *Aplysianæ*, but there are several exceptions. In the genus *Aplysia* Linn., the body is excessively thick, and the lobes so large that they can be used for swimming: but in *Thallepus** Sw., the form is much more slender, the lobes shorter, "the eyes not visible," and the lower pair of tentacula wanting. *Dolabella*, according to the published figures, is pear-shaped; the broadest part, which is rounded, being posterior, where there is an oblique disk, and a hatchet-shaped shell which covers the branchia. The next genus, *Bursatella*, is still shorter, so as to become nearly globular; and the edges of the mantle are united over the back, so that there is merely a passage for the water to pass to the gills. The fifth genus, *Notarchus*,

* Thallepus *ornatus* Sw. A most beautiful figure of a species to which I give this name, is among Guilding's drawings, but without any description; it was evidently finished from the living animal. The general colour is sea green, covered with minute black and white dots; the edges or crests of the reflected mantle have a broad edging of the richest orange, bordered on their outer edge with a line of deep black; the tentacula are also orange, and formed like those of *Aplysia*. Total length about 3¾ in. The only memorandum on the drawing is, "eyes not visible:" whether this had any covering over the branchia I have no means of judging.

closely resembles the last in its mantle, but is remarkable for the body being beset with large, flat, irregular-shaped and palmated membranes, as if it was overgrown by sea weeds; the tentacula are only two, and these also are covered with similar processes as long as themselves; there is no shell; and the mouth, resembling a small longitudinal slit, is placed beneath.* We have no doubt that all these, hereafter, will be found to contain sub-genera, some of which we may subsequently characterise.

(235.) In regard to the BULLINÆ, we have already stated our difficulties, as they now stand in Lamarck's and Cuvier's arrangements. Some have external, some internal, shells, thin or strong, horny or calcareous, coloured or hyaline; in all these, however, the oviform or bulla-shape is uniformly preserved. The annexed cut from Guilding's drawings of a species allied to *B. aperta*, will show how nearly the animal is related to the *Aplysianæ*, while it gives a correct idea of the general character of such types as have their shell concealed.



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In the genus *Doridium*† of Mecken, the shell almost disappears; according to M. Rang‡, the two lateral lobes of the animal are so much developed that they can be used as fins. Many of the *Bullinæ* have the gizzard composed of bony pieces; the tentacula assume the appearance of large, fleshy, angulated processes, under which are very minute sessile eyes.

* See Rüppell's admirable figure of *Notarchus laciniatus*, Atlas, i. pl. 7. fig. 2.

† *Akera* Cuv.

‡ *Manuel de L'Hist. Nat. des Mollusques*, p. 146. The reader will find a great deal of original and valuable information in this unpretending but excellent little volume.

(236.) The two next types are *Gasteropteron* and *Pleurobranchus*. The first is a most interesting form, since it connects the tribe with the CEPHALOPODA. Cuvier, however, with his usual infelicity (wherever natural affinities are concerned), simply remarks, that it "appears to be an *Akera*, the margin of whose foot is developed into broad wings for swimming, which it performs on its back. It has no shell or stony armature to the stomach; a slight fold of the skin is the only vestige of a branchial operculum that is visible."* A much better account, however, is given by M. Rang †, who observes, that this "highly interesting" animal was first made known by M. Della Chiaje, the learned anatomist of Naples, who considers it so clearly a *Pteropoda*, that he has named it *Clio Amati*.

(237.) The last genus, or rather sub-family, is the PLEUROBRANCHINÆ, distinguished from all others by their broad, flattened, and oval bodies; but especially by the feather-like structure of their gills, which are placed on the right side of the body, just under the edge of the mantle. Here, again, we recognise the cheloniform type so frequently developed among the *Testacea*, and of which *Chelisoma*, *Chelinotus*, *Parmophorus*, *Chiton*, &c. are such striking examples. The bodies of all the animals now before us are shaped like those of tortoises; and in some, as *Pleurobranchus* Cuv., this resemblance is carried so far, that the foot represents the under plate of those reptiles; so that, to use the words of Cuvier, "the body is equally overlapped by the mantle and by the foot, as if it were between two shields." The mantle, in some genera, contains a calcareous plate, which in Lamarck's *Umbrella* is so very large and strong as to resemble a limpet, but is immediately known by the sharp edge of its circumference. The idea that this shell could by any possibility have ever been *naturally* attached to the *foot* of the animal (whence the name *Gastroplax*), is too preposterous to require further notice. We here

* Griff. Cuv. xii. 46. † Rang, Manuel, p. 148.

close our survey of the *Tectibranchia*, and with it the whole of the pre-eminently typical TESTACEA. The little space now left, will therefore be devoted to the sub-typical order.

CHAP. X.

ON THE ORDER DITHYRA, OR BIVALVE SHELLS. — THE AFFINITIES AND ANALOGIES OF THE UNIONIDÆ, OR RIVER UNIOS.

(238.) OUR survey of the gastropod shell-fish has so much exceeded the limits we originally intended, that we can do little more than bestow a hasty glance on the remaining TESTACEA. Comparatively so few of the forms among the GASTEROPODA had been defined by our predecessors, that it was absolutely necessary to treat that order in much detail: but this is not the case with the DITHYRA; nearly the whole of the genera and sub-genera have been defined; with the single exception of the UNIONIDÆ, to the illustration of which we have consequently devoted the greatest part of this chapter. A few remarks on the remaining families, with an exposition of their analogies, is all that our space will admit. We could, indeed, have easily made this single order alone the subject of another volume; but as nearly all the genera may be said to be established, and their technical distinctions are given in the systematic arrangement, the reader must be satisfied with the *results* rather than with the *details* of our analysis.

(239.) The DITHYRA*, or bivalve shell-fish, are animals whose general structure resembles that of the oyster. They are without any distinct head, and are inclosed in two shelly valves, which, by means of certain muscles

* Comprising the first order of Cuvier's *Acephala*, the seventh order of his *Gasteropoda*, and the fifth class of his *Mollusca*.

running through the body, and of a cartilaginous ligament, can be opened and shut like the covers of a book. Upon opening these, the mantle is seen to form a thin covering over all the interior surface of the shell; upon this being raised, four thin lobes, much smaller, will be discerned, called by Cuvier the "branchial leaflets;" these, again, envelope the internal parts, as the heart, foot, &c. "On the sides of the mouth are four triangular leaflets," which, according to Cuvier, "are the extremities of the two lips, and serve as tentacula;" the foot is a mere fleshy mass, and is moved about "by a mechanism analogous to that of the tongue in quadrupeds." The animal is attached to its shell either by a strong central muscle, as in the oyster; or by two transverse ones, which cross from one to the other valve, and leave roundish indentations, generally called muscular impressions. These muscles, however, are of secondary importance, when compared to the remarkable modifications of the animal. In the most typical *Dithyra*, forming our MACROTRACHIA, the mantle is so united and prolonged as to form one or two long siphons or tubes by which the food is imbibed; while in the next tribe, ATRACHIA, these siphons are entirely wanting. The latter animals are also distinguished by a considerable number of the genera having the power of forming a bunch of cartilaginous threads called a *byssus*, which they protrude from a small opening between the valves, for the purpose of affixing themselves to marine substances: the whole are hermaphrodites. Such are the two chief or typical tribes of the *Dithyra*. The three which are aberrant, lose several of these characters, and possess others. In the TUBULIBRANCHIA, which connect the *Dithyra* and the *Gasteropoda*, the structure of the animal is a singular compound of both tribes; while its tubular shell reminds us of a *Teredo* fixed on other substances externally instead of internally. The CHELIOSOMIDÆ, instead of a testaceous, has a coriaceous covering, analogous to the chitons and the tortoises; while the BRANCHIOPODA, although bivalve shells, are attached by a fleshy peduncle or a strong liga-

ment, which passes through the apex or summit of one of the valves: "like the other bivalves," as Cuvier observes, "they have a bilobed mantle, which," as in the oysters, "is always open: instead of feet, they have two fleshy arms, furnished with numerous filaments, which are protruded or withdrawn at pleasure." Nearly all of them possess (like their prototypes, the *Cephalopoda* and the *Tectibranchia*) an internal bony support, which in these consists of a sort of framework closely resembling an internal skeleton, and rather complicated. Although innumerable fossil shells of the *Branchiopoda* abound in the older formations, very few occur in a recent state. Our arrangement of the entire order will thus be in the following tribes:—1. The MACROTRACHIA, where there are either one or two siphons; 2. The ATRACHIA, having none; 3. The TUBULIBRANCHIA, or tubular shell-fish, having an indistinct head, and an operculum to their shell; 4. The CHELIOSOMIDÆ, with a cartilaginous covering and two orifices; and, 5. The BRANCHIOPODA, or anomian bivalves. The whole of these, it will now appear, have their prototypes in the *Gasteropoda*.

Analogies of the Orders DITHYRA *and the* GASTEROPODA.

Tribes of the *Dithyra*.	*Analogies*.	Tribes of the *Gasteropoda*.
MACROTRACHIA.	Animal with the mantle formed into an elongated siphon, simple or double.	ZOOPHAGA.
ATRACHIA.	Mantle free, and without a siphon.	PHYTOPHAGA.
BRANCHIOPODA.	Reciprocally representing the *Cephalopoda*.	TECTIBRANCHIA.
CHELIOSOMIDÆ.	Body cheloniform, oval, covered with testaceous or coriaceous plates.	CYCLOBRANCHIA.
TUBULIBRANCHIA.	Animal of the gastropod structure, furnished with an obtuse head.	SCUTIBRANCHIA.

This table is important, were it only to prove that the usual divisions of the more typical bivalves according to the number of their muscles, whether one or two, is not a natural arrangement; because it destroys

the beautiful analogy which is found to exist in the two typical tribes of the *Dithyra* and the *Gasteropoda*, and is not borne out by the details of their analysis.

(240.) The MACROTRACHIA and the ATRACHIA comprise by far the greater number, and the most perfect, of all the bivalves: and that they each form a circular group, will be apparent from the following considerations. The MACROTRACHIA may be said to have their first developement in the family of *Pholidæ*,— several of which, as *Teredo*, *Clavagella*, &c., assume the form of the *Tubulibranchia*. By means of *Pholas* and its sub-genera, there is a direct passage to the *Myadæ* through *Solen*: these semitubular shells are succeeded by *Mya* and *Mactra*, where all appearance of the gaping peculiarity of the *Myadæ* ceases. We enter the *Tellinidæ* by means of the river genera allied to *Cyclas*; and thus, through *Venus*, reach the *Tellinæ*, where the two siphons of the animal are of enormous length. *Cardissa* Sw. and *Pleurorynchus* of Phillips open the passage to the CHAMIDÆ, where we see the siphons much reduced, and almost obsolete in *Hippopus* and *Tridacna*. The aberrant genera of *Cardita* and *Chama* unite with *Cypricardia*, and lead to the perforating family of the SAXICAVIDÆ, into which also enter *Petricola*, *Saxicava*, *Coralophaga*, and *Thracia*. Finally, all these are as evidently connected to *Galeomma*, as *Galeomma* is to *Gastrochina*. Thus we again arrive among the *Pholadæ*, and the circle of the MACROTRACHIA is closed.

(241.) The course of the ATRACHIA is precisely similar. Cuvier has already pointed out the connection of the *Chamidæ* to the *Unionidæ*; while the genus *Iridina* in the latter, and *Nucula* in the ARCADÆ, show that the two families follow each other. The passage from these to the AVICULIDÆ is still more perfect, upon looking to the genera *Byssoarca* and *Modiola*: then follow *Crenatula*, *Malleus*, *Avicula*, and *Pinna*, which, uniting to *Modiola*, completes this group. *Avicula* opens the passage to the OSTREIDÆ, which are entered

by means of *Lima* and *Pecten*. Finally, in order to close this circle, we have the ETHERIDÆ, which, with *Mulleria*, "is remarkable as a group possessing in itself both the character of being intermediate between *Etheria* and *Ostrea*, and as apparently connecting the regular freshwater bivalves with the regular marine bivalves, as *Ostrea*.* The sinus at the posterior extremity of the ligament of *Mulleria* resembles the *Unionidæ* and the *Etheria;* while in its single muscular impression, as well as its general form, it approaches to *Ostrea*." This obvious affinity at once closes the circle of the ATRACHIA, by the series returning to the *Unionidæ*. The following table will consequently exhibit the mutual relations of both these tribes:—

Analogies of the MACROTRACHIA *and the* ATRACHIA.

Families of the *Macrotrachiæ*.	*Analogies*.	Families of the *Atrachia*.
TELLINIDÆ.	Shells very compact, the valves closed.	ARCAIDÆ.
MYADÆ.	Valves gaping at one extremity.	AVICULIDÆ.
PHOLIDÆ.	Animals affixed to, or living within, other substances.	OSTREIDÆ.
SAXICAVIDÆ.	Shells irregular, without teeth.	ETHERIDÆ.
CHAMIDÆ.	Lateral teeth long, linear, only on one side of the bosses.	UNIONIDÆ.

(242.) It will be seen, by the subsequent arrangement of the genera, that they follow each other precisely in the same way, so as to represent the families. To follow out this exposition, however, in the present tribe, as we have already done in that of the *Gasteropoda*, is manifestly impossible ; but, as we state this fact as the result of a careful analysis of the whole, the reader, knowing the general principle, may apply it to any particular group, whose analogies he wishes to trace. As we shall enter into a full investigation of the *Unionidæ*, or river pearl-shells, our remaining space will

* Sowerby's Genera of Shells, art. *Mulleria*.

barely be sufficient for a few general remarks on the other families; and these will be confined to the forms most characteristic of the primary types of bivalves.

(243.) The *Tubulibranchia*, or tubular tribe, may be traced in almost every one of the above families: it is shown by an unusual elongation of the shell, which is at the same time very narrow, and inclined to be cylindrical. The whole of the Solens have this analogy, as well as the genus *Anatina*, in the *Myadæ*. *Psammobia* and *Donax* are modifications of the same; and so also is *Cardissa:* most of these also have the anterior side remarkably short, precisely as in all the *Pholadæ*. *Coralophaga* is another example; and it is even apparent in one of the sub-genera of *Cardium*. This type of form is equally, and even more strongly, developed in the order ATRACHIA: thus, we detect it in *Iridina*, *Byssoarca*, *Lithophaga*, and *Avicula;* all of which are the most elongated in general shape, and the most abbreviated at their anterior extremity. In another type, which evidently runs through the whole, it is characterised either by the absence of all teeth to the valves, or by there being but two, placed in the centre, and resembling the letter V reversed. This is almost always found in that division of a group which is most aberrant in its own circle, as the *Saxicavidæ* and the *Etheridæ;* the *Anodontinæ* among the river bivalves; as well as the genera *Pholadomya*, *Thracia*, *Acardo*, *Loripes*, *Pinna*, *Placuna*, *Plicatula*, *Trigonia*, *Pandora*, &c. A third type of form is evidently intended to represent the BRANCHIOPODA; its chief distinction being that of having an internal cartilage—not, indeed, protruding through an opening in the valves, but situated between the cardinal teeth. This is well known to be the predominant characteristic of all the *Mactridæ*, and of their prototypes scattered in other groups, as *Gnathodon*, *Erycina*, *Nucula*, *Ungulina*, *Pecten*, *Pedum*, &c. Now, it is a remarkable fact, that, on comparing our analysis of the whole of these circular groups, we almost invariably found that these three

types always followed each other, and that they constituted the aberrant divisions. On looking to the typical and the sub-typical divisions of the larger groups, we find that the first are the most perfectly closed bivalves, or the most highly finished and ornamented; while the latter seem not to have so much the power of free motion, and usually gape a little at one extremity, — a sure sign that their inhabitants live in the ground, and do not roam from place to place. In the tribe of *Macrotrachia*, we thus have the pre-eminent type in the *Tellinidæ*, and the sub-typical in the *Myadæ*; the former being represented again by the *Arcidæ*; and the latter by the *Aviculidæ*. We must, however, quit this inviting train of generalisations, and proceed at once to the only family of the *Dithyra* which stands in need of a more detailed examination.

(244.) The UNIONIDÆ, as before observed, are entirely fluviatile, and are the only river shell-fish in this tribe; except indeed the *Etherinæ*, by which they are connected to the marine oysters. As they form that particular family which unites the *Atrachia* to the *Macrotrachia*, we naturally supposed, that when they were better known, some trace of the siphons so characteristic of the latter tribe would be found in one of the aberrant groups; and in this expectation we have not been disappointed. M. Deshayes, it appears, has announced the fact, that the animal of *Iridina* possesses these tubes; and it further appears that the major part of the family, although really without these organs in a permanent state, have yet the power of forming two temporary tubes, with the posterior edge of the mantle, which is fringed with cilia, serving to determine the direction of the water which flows into the branchia.* Thus, whether we regard the shell or its animal, we find that the natural station of the *Unionidæ* is determined by nature; they are the last of the *Atrachia* as the *Chamidæ* are the first of the *Macrotrachia*.

* Lea's Synopsis, p. 5.

(245.) As the whole of these shell-fish are inhabitants of fresh waters, and chiefly of rivers, so are they most abundant in those countries whose lofty mountains supply copious and never-failing supplies of their favourite element. The mighty rivers of the New World are no less remarkable for their innumerable ramifications, than for the almost endless number of these shell-fish which live in them. The American species, in fact, comprise more than seven tenths of the whole number yet made known; five or six are alone found in Europe; about the same number occur in Australia, a few more in Asia, and we have as yet seen none from Africa. Why the immense rivers of the East should be so destitute of *Unionidæ*, is a question we know not how to solve. One reason may probably be, that they have not been sufficiently examined. Before the researches of Spix and Martius in Brazil, scarcely five were known from South America, — so that nearly all that they found were new, and others will no doubt be soon brought to light. It is difficult, indeed, to assign any reason why the tropical rivers of the New World should not produce these shell-fish at least as plentifully as the more temperate waters, such as the Ohio and its tributary streams. The *Unionidæ* almost always have their bosses more or less rubbed and injured, occasioned by the friction of stones and other substances carried onward by the stream. Although generally of an olive brown colour, occasionally varied with obscure rays on their outer surface, the interior of these shells are often particularly brilliant, and their substance is always perlaceous. Hence they are now manufactured in America into pearl buttons and other ornaments. Real pearls, also, are occasionally found in some of the species. We once took from a small specimen of *U. circulus*, a beautiful little pearl, half the size of a small pea, which is now in the possession of our friend Mrs. Corrie of Birmingham. The *Mya margaritifera* Linn., still found in some of our own rivers, produced those pearls for which Britain was so famous in the time of the

Romans. Some of the American species are remarkably thick, particularly at their bosses, which, in proportion as they are rubbed, the animal thickens internally; and this is very remarkable in old shells. In regard to the anatomy of the animals, we must refer the reader to Poli's account of the European species, and to the scattered notices of the American in various other publications.

(246.) The natural arrangement of this family, or rather the *principle of its variation*, in regard to the shell, is precisely the same as in all the other groups of the DITHYRA. The most typical groups are those two which stand between the elongated and the cuneated types; the most aberrant being intermediate with the two latter, and having no teeth. The typical groups, consequently, possess the two sorts of teeth, cardinal and lateral, in the highest perfection; while, in the three aberrant divisions, only one of these sorts is apparent, or none. As a whole, this is the most perfect family, perhaps, of the bivalve *Testacea*. Like the *Psittacidæ* and the *Picidæ* among scansorial birds, the shells of the *Unionidæ* have such a stamp of identity upon them, that they cannot possibly be confounded with those of any other family; while their amazing diversity, on the other hand, offers the very best facilities for determining the natural succession of their forms. Under the belief that this would long ago have been done by those American conchologists who have especially studied this portion of their native fauna, we suspended our labours towards this object some years ago; but as nothing has yet been done to supercede our own views, they will here be detailed with as much brevity as the subject will admit.

(247.) Presuming that the station of the *Unionidæ*, as a family, has been determined; and that *Iridinæ*, from possessing true siphons, is that aberrant group which comes nearest to the *Chamadæ* in the tribe of *Macrotrachia*, we thus get a sure point from which to start: our first object is to show that the whole family form a circular group, with no chasm, hiatus, or inter-

ruption so great as to cast a doubt on the truth of this proposition, or to admit the introduction of any shell-fish that have been arranged in other families. On this ground, and not for its typical perfection, we commence our survey with *Iridina*, where the transverse or tubuliform structure of shell is so conspicuous: here the cardinal teeth are wanting, being absorbed in one single lateral tooth which occupies the whole length of the hinge margin; this lateral tooth being tuberculated or crenated. Now, the only other examples where the cardinal teeth put on the aspect of lateral teeth, and are also crenated, is in such shells as *Hyria avicularis* Lam., where, in fact, the cardinal teeth * are so far removed towards the side as to assume the aspect of lateral teeth; the interval between those on the other side of the shell being occupied by a few irregular crenations, similar to those, in short, of *Iridina*: on coming to *Hyria corrugata* Lam., these crenations disappear, the cardinal teeth assume their true position immediately under the bosses, and the passage thus becomes opened to Lamarck's *Castalia*. The Indian *Unio corrugata* Lam. then succeeds, and from standing at the confines of HYRIA, connects that group, in conjunction with other species more elongated, with *Mysca ovata* of Turton. This brings us at once to the genus UNIO of Lamarck, where the chain of affinity passes on from *Mysca nasuta* Sw. to the *Unio ossidens*. The pre-eminent types of the whole then succeed, as shown in *U. cuneatus* and the *Mytiloides* of Raf. By means of *U. Æsopus*, we pass to Lamarck's *sinuosa*, *Unio gibas* Sw., and so enter Say's ALASMODON by the well-known *Unio margaritifera* of Europe. From this point even the cardinal teeth begin to disappear; for *A. undulatus* and *calceolus* bring us close to, and *rugosus* within, the confines of ANODON: all that now remains of the teeth is a slight elevation beneath the hinge margin, as in *Dipsus* Leach; and even this finally disappears, as in the typical anodons. Gradu-

* True cardinal teeth are placed immediately beneath the bosses, and not on one side, as in *Hyria avicularis*.

ally, however, the shell becomes stronger, more elongated, and the hinge margin again thickened: this is particularly observable in a species from the Nile *, placed by some writers as an anodon, and by others as an *Iridina;* but to which it really belongs is not, at present, material. Suffice it, that thus the series of the *Unionidæ* returns into itself, and forms as perfect a circle as any, perhaps, contained in this volume.

(248.) The proportion which the three aberrant divisions bear to the pre-eminently typical, is nearly the same in this as in all natural groups of the animal kingdom. By far the most numerous in forms and species is the typical genus *Unio*, which contains, in fact, more than all the rest put together; the fewest, perhaps, are in *Hyria* and *Iridina:* hence it naturally results, that the interval between the species, in these two latter, are wider than in the former. But these little intervals, more or less, occur in every group in nature; and provided that no animals are found in other groups, which appear to fill up these chasms, we may be quite sure our series is correct. In the *Unionidæ*, this perplexity can never happen; their general structure is so peculiar, that no intervals among them can be filled up by shell-fish of other groups: hence we may feel perfectly sure that the break in the line of continuity originates either from a few links having not yet been discovered, or that they exist only in a fossil state. The proximity, for instance, between *Iridina* and *Anodon* is so close, that there is not the slightest link wanting; but between *Iridina* and *Hyria* the difference is more marked. Are we, then, to conclude from this, that these two are not also connected? Certainly not. We know that *Hyria* is imperceptibly united to *Unio*, on one side; and if, on the other, it approaches nearer to *Iridina* than does any other genus, we have inductive proof that they follow each other, although one or two of the links may appear wanting.

* This may possibly be the *A. rubens* Lam.

(249.) The primary divisions of this family, as we stated some years ago, are typically represented by the following genera: — *Unio*, *Hyria*, *Iridina*, *Anodon* of Lamarck, and *Alasmodon* of Say.* Having shown that these form a circular group, it follows, that these divisions are sub-families, to which we give the usual termination in *inæ*. Their secondary groups are consequently genera, and their third are sub-genera. We shall now take a rapid survey of each in their natural order of succession.

(250.) The UNIONINÆ stand at the head of the family; and their typical characters may be thus briefly stated: — The form is various, but the two cardinal teeth† and the anterior lateral teeth are always present; the umbones, or bosses, are sometimes wrinkled longitudinally, but never sulcated transversely, — this latter character being peculiar to *Hyria*. Thus detached by the most simple and definite characters furnished by the shell, we find the whole of the species will arrange themselves under one or other of the following genera: — In *Unio* pre-eminently so called, the umbones, or bosses, are very large, thick, and prominent; and the cardinal teeth (*fig.* 47. *a*) either in an obliquely perpendicular line with the base of the shell, or receding in a contrary direction, to the anterior margin. The form is various; but the hinge margin, al-

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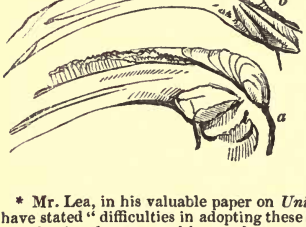

* Mr. Lea, in his valuable paper on *Unionidæ* (Am. Tr.), observes that I have stated "difficulties in adopting these genera." I am not conscious of ever having done so, and have taken every occasion of expressing my belief that they are perfectly natural. As I entirely dissent from the views of this gentleman, both in his divisions, in his genera, and even in many of his species, I am anxious not to be misunderstood, as having in any way changed my opinion on this family. Mr. Lea has, however, added many interesting and beautiful species, for which he deserves the thanks of every naturalist; we only regret that all his arrangements of them appear to us so very artificial and perplexing.

† I consider these teeth as two; not as *one*, *cleft* into two.

though sometimes angulated, in the most aberrant groups, is never connate; nor is the shape of the shell properly cuneate. In the next genus, *Æglia* Sw. (*b*), the cardinal teeth are lengthened, compressed, and take a direction precisely opposite to the above; they diverge, in fact, from the apex *towards* the anterior margin instead of *from* it: the inner tooth is smallest, and not, as in *Unio*, the largest. The shell is generally cuneate and the bosses prominent. None of the types are connate or tuberculated. In *Mysca* the shells are more or less transversely elongated, much thinner, and the bosses much smaller than in the two preceding genera; and the cardinal teeth differ essentially from both: they are much compressed, irregularly crenated, and placed as nearly as possible on a parallel line with the anterior margin; they are also sometimes so thin and slightly divided, that they appear almost blended into one: hence they are rarely obtuse, nor is the shell winged or tuberculated. In *Lymnadia alata* (*fig.* 48.), the posterior part of the hinge margin is greatly elevated, and the shell is strictly connate; while in *Megadomus*, of which our *M. gigas* is the type, the cardinal teeth are like those of *Unio*, but there is only one lateral tooth in each valve.

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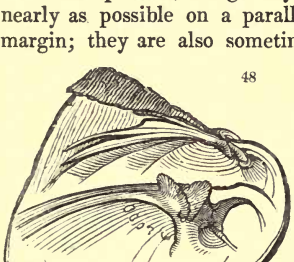

(251.) To these groups we shall presently return; in the mean time it will be as well in this place to show how perfectly they represent the five primary divisions of the whole family. It is immaterial to our present object, whether the genus *Mysca* contains a portion of those shells we have arranged under the name of *Potomida*, since none of these latter can be looked upon as typical examples of *Mysca*.

Analogies of the Genera of UNIONINÆ.

Genera of the *Unioninæ*.	*Analogical Characters.*	Types of the Sub-families of the *Unionidæ*.
Unio.	Cardinal teeth thick, short.	UNIO.
Æglia.	Cardinal teeth compressed, lengthened; shell cuneate.	HYRIA.
Mysca.	Shell lengthened; cardinal teeth crenated, almost on a line with the lateral teeth.	IRIDINA.
Lymnadia.	Shell thin, winged; umbones small.	ANODON.
Megadomus.	Lateral teeth imperfect, one or none.	ALASMODON.

These analogies are very remarkable, particularly when we confine our attention to the types of each of the groups thus brought into comparison. *Æglia ovata* Sw. (*Unio ovatus* of Say) (*fig.* 49.), like *Hyria*, has the cardinal teeth assuming the shape and the position of lateral teeth; and both have merely two or three tubercles immediately beneath the bosses. The elongated form of all the species of *Mysca* reminds us of *Iridina*, no less than the crenated edge and marginal direction of the cardinal teeth. If *Lymnadia*, again, had no cardinal teeth, it would be a *Dipsus* of Leach; and both these have the very aspect of *Anodon*. *Megadomus* is the only type in which the lateral teeth are imperfect; hence a truer prototype of *Alasmodon*, where both those teeth are entirely wanting, could scarcely be found; particularly as the cardinal teeth are precisely like those of the typical genus *Unio*. Our limits, and, indeed, our materials of specific nomenclature *, will not permit us to analyse the whole of

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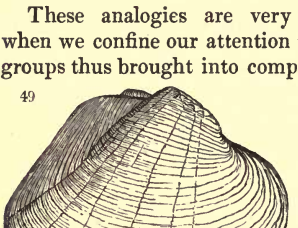

* The specific descriptions of Lamarck are scarcely less unsatisfactory than many of those recently published in America; I have seen totally

these genera. Two, however, where the natural series appear to us very strikingly marked, will be now noticed: the first regards the sub-genera of our genus *Unio*, and the circular succession of the types of form in two of them.

(252.) The genus UNIO, separated by its cardinal teeth from ÆGLIA, as already shown (*fig.*47.*b*), contains five distinct types of form, which, from the multiplicity of species, and for the greater facility of nomenclature, we shall designate under the following sub-generic names:— 1. *Unio:* the bosses or umbones prominent and tumid, the circumference and the posterior hinge margin never angulated, and both the cardinal teeth very much receding from the anterior margin, as in *U. Mytiloïdes* Raf., and all such species or varieties. 2. *Cunicula*, where the umbones are even larger, but not tumid, being, as it were, compressed or flattened: the shell is generally oval, or angulated at the base of the posterior side;— examples, *C. planulata, cuneata, purpurata*, Lam., &c.: the outer cardinal tooth slightly diverges from the base of the inner. 3. *Ligumia:* the form is particularly long, like that of *Iridina*, the umbones small and retuse, and the cardinal teeth close to the anterior end; as in *U. recta* Lam. 4. *Theliderma:* the form is various, but the posterior hinge margin is generally elevated and angulated, and the outside of the valves tuberculated or granulated,— a character not

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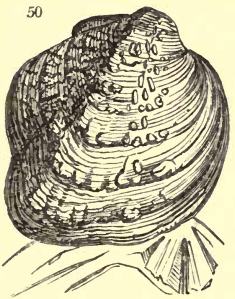
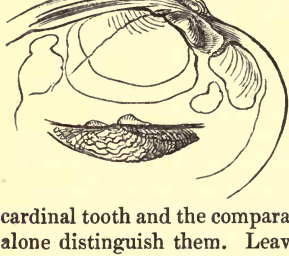


distinct species sent from that country, evidently labelled by the same hand, yet bearing the same specific name. Mr. Lea's *Synopsis* leaves this part of the subject almost as obsure as ever, because he merely cites the *name*, without giving any reference to the *works* of the authors he quotes. By his plan, as novel as it is detrimental to science and all critical inquiry, the author (no doubt, unintentionally) imposes an effectual bar to the verification of his own nomenclature, no one here being acquainted with all the detached papers on these shells printed in America.

found in any other of these groups* (*T. metanevra* Raf. *fig.* 50.). 5. *Potomida:* the shell rather short and oval; the umbones prominent, but not so large as in *Unio;* the outer surface smooth; the cardinal teeth thick, perpendicular, but the outer one diverging. These are mostly European shells, and are represented by *U. sinuata* Lam., and our *P. corrugata* (*fig.* 51.). Between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these sub-genera are intervening species, or rather types of form, which blend the whole into a continuous chain of affinity; thus *P. sinuata* is so like some of the typical Unios, that the direction of the outer cardinal tooth and the comparative smallness of the bosses alone distinguish them. Leaving, however, these intervening or connectant species, and looking only to the types, we shall see by the following table that they have a resemblance to the primary divisions of the whole family, and to the genera of the *Unioninæ*.

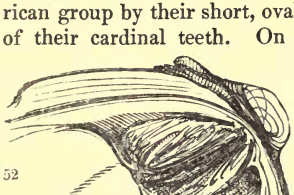
Analogies of the Sub-genera of UNIO.

Sub-genera of *Unio*.	*Analogies*.	Sub-families of *Unionidæ*.	Genera of *Unioninæ*.
Unio.	Shell ovate; cardinal teeth not diverging.	UNIONINÆ.	UNIO.
Cunicula.	Shell more oval, wedge-shaped, and angulated.	HYRINÆ.	ÆGLIA.
Ligumea.	Shell very much lengthened.	IRIDINÆ.	MYSCA.
Theliderma.	Posterior hinge margin generally winged.	ANODONINÆ.	LYMNADIA.
Potomida.	General form oval, oblong; cardinal teeth obtuse, diverging, sometimes erect.	ALASMODONINÆ.	MEGADOMUS.

The analogy of the last three groups is not so satisfactory as the others, and this excites a suspicion that

* Except *U. cornutus* and *Æsopus*. *U. nodosa*, Wood's Conch. pl. 22. fig. 1, 2., seems to belong to this group.

our *Megadomus* fills up the interval between such species as Lamarck's *Peruvianus* and *Æsopus;* but this would exclude the European *Unio sinuata, littoralis,* &c., which seem closely united to the typical or American group by their short, oval shape, and the thickness of their cardinal teeth. On the other hand, we feel persuaded that our *Potomidæ* must be kept distinct from the sub-genus *Unio;* and this will be apparent to every one who looks to the annexed cut of the cardinal teeth of *Unio Mytiloïdes* (*fig.* 52.), and those of *Potomida corrugata* (*fig* 51.).



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(253.) Two of these sub-genera, being more than usually perfect in their types of form, or, in other words, in the diversity of their species, will next be glanced at, for the purpose of showing there is but one principle of variation throughout the entire family. We shall first take the sub-genus *Unio* as here restricted. The types of this are seen in those inequilateral shells which have been sent to us from America, as the *U. Mytiloïdes* Raf. and the *undatus* of Barnes. Next follow those which are nearly round and equilateral, such as *U. Torsus* Raf. Our *U. truncatus,* very much elongated, is the third type of form. The fourth, which represents *Theliderma,* is perhaps the *cornutus* of Barnes; while the fifth, which unites the last to the first type, is an American species, formed like *obliqua* Lea, but with small scattered tubercles down the middle.* This unites with *Æsopus,* and again brings us back to the *undatus.* Thus, in the confines of a single sub-genus, are types of ÆGLIA, in *U. Torsus;* IRIDINA, in *U. truncatus;* ANODON, (through THELIDERMA), in *U. nodosa;*

* I pretend not to enter upon specific names, for nearly all those which belong to species unfigured appear to me one mass of confusion.

and probably of ALASMODON, in the species mentioned above. We say *probably*, because, as there is no especial evidence to prove the fact, we only infer it from this shell having a structure intermediate between *nodosa* and *Æsopus;* hence, it occupies the same station in its own circle, as *Alasmodon* does in that of the whole family.

(254.) So astonishingly variable, however, are the shells of this family, that we may even carry our analysis still further; and by following the series of species which arrange with *Unio Mytiloïdes*, we shall detect the same analogies as are apparent in the last investigation. Thus, some of the species or varieties of *Mytiloïdes* (as *gibbosus*) are almost equilateral; others pass into *Ellipsis* and *sulcatus* of Lea, thus assuming the long shape of *truncata* and IRIDINA; next follows *cornutus*, as a prototype of *nodosa* and *Theliderma;* and finally, *Æsopus* brings us again to such shells as *U. obliqua*, and the inequilateral varieties of Lea's *gibbosus*. Beyond this point, it is utterly impossible to push analysis, except it be carried into the principle by which the *varieties of each species* are regulated; and this, we firmly believe, is in conformity with the very same laws. We have seen, in fact, four varieties of the *Mytiloïdes*, which assume four out of these primary forms. Some are inequilateral (*fig. 53.*), some trigonal, others are oval, and another oblong: whether there is any one with small nodules to represent *cornutus* and its prototypes, we know not, but we have no doubt that such a variety will be found.* *Mytiloïdes*, therefore, we consider as the most typical species of the whole family, concentrating, in its own variations, pro-

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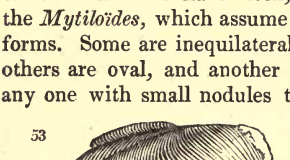
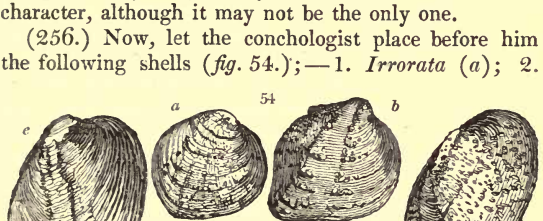


* Since writing the above, we have seen a variety of *Mytiloïdes* perfectly answering our theoretical description, in the hands of Mr. Stuchbury.

totypes of all the natural divisions, large or small, of the UNIONIDÆ.

(255.) The other sub-genus, which contains sectional types, is THELIDERMA; and this we shall now briefly notice. It will be remembered that we have placed this sub-genus immediately after *Ligumia*, the type of which is the *Unio recta* of Lamarck. Nearly all these shells have their posterior margin dilated and angulated, and thus represent the genus *Anodon* of Lam. Although the species are remarkably varied, they are all known by the external surface being covered by numerous tubercles of different shapes, which stud every part of the shell. Where we find a character, however trivial it may appear, pervading a whole group, we may be perfectly assured that it is a natural character, although it may not be the only one.

(256.) Now, let the conchologist place before him the following shells (*fig.* 54.);—1. *Irrorata* (*a*); 2.



Metanevra (*b*); 3. *Cylindrica* (*c*); 4. *Pustulata** Sw. (*d*); and, 5. *Plicata* (*e*);—and he will then have what we consider the sectional types of THELIDERMA. It is obvious that the two first have the greatest resemblance to each other; both are nearly circular, and tuberculated; but *irrorata* is not winged, like *metanevra*. Now, this difference, trivial as it seems, is accompanied

* We merely use this name provisionally, until we know that by which it has been distinguished in America.

by a peculiarity in the construction of the animals, first ascertained, we believe, by Mr. Lea. Here, then, we have two obvious modifications of semicircular warted shells — the one winged, the other not. This rounded shape, however, begins to be lost in succeeding species, and we are thus conducted to that singular shell the *Unio cylindricus* of Say (*c*). Notwithstanding its uncommon length, it yet preserves, in every other part of its outward appearance, such a close affinity to *metanevra* (*b*), that, without knowing *why*, a conchologist would at once place them together. On turning to *plicata* we see another modification: this species is neither semicircular, like *metanevra*, nor elongated, like *cylindrica;* it is broadly oval; and, instead of being tuberculated, has merely two or three deep oblique furrows: it exhibits, in short, but one out of the three typical characters, — namely, the winged elevation of the posterior angle. We believe more than two or three species pass under the name of *plicata*. In one of these, kindly sent us by our liberal friend Mr. Cooper, of New York, and labelled as "a very old specimen," there is but one lateral tooth on the right valve, instead of two; so that this species or variety actually puts on the very character of our *Megadomus gigas* *, and renders both prototypes of *Alasmodon*. But has Nature no *method* in these remarkable variations? Can it be supposed that the deviation of species, or of races of the same species, are regulated by no fixed principles, while all the rest of creation, inconceivably diversified, has been created on one and the same plan? Every analogy of reasoning, every ascertained fact, is against the supposition. Whence, then, does the species before us put on the very aspect of another genus? Simply for this reason, — that *plicata*, and its immediate allies, represent the genus *Alasmodon*, and that Nature adopts this mode of instructing us in her favourite theory of representation. With *plicata* must be associated our *Unio rugosus*,

* It is this fact which so strongly leads me to suspect that there may be some error in our location of *Potomida*.

where the form of the shell is nearly semicircular, so that we again return to *irrorata*, from whence we first set out. Four types of the group are now disposed of, but another is obviously wanting; because, although there are representations of four genera of the *Unionidæ*, we have not yet noticed the prototype of *Anodon*. Now, this type is in the Manchester Museum, and was sent to us, many years ago, by our friend professor Rafinesque, without a name. By the annexed figure (*d*), the conchologist will perceive that, in its outward appearance, no one would suspect it was really different from the *Alasmodon rugosa* of Barnes; yet, on opening the valves, we find the perfect cardinal and lateral teeth of *Theliderma*. The anodons are remarkable for the smallness and the depression of their summits; and this is the only shell of its own group which possesses this character, while its form is exactly intermediate between *cylindrica* and *plicata*. Condensing the results of these remarks, we find the sectional types of this sub-genus will represent all those of the entire family,—and in the following manner:—

Analogies of the Sectional Types of THELIDERMA.

Sectional Types.	*Analogical Characters.*	Genera of *Unionidæ.*	Genera of *Unio.*
Irrorata.	Semicircular, but not winged.	UNIO.	UNIO.
Metanevra.	Semicircular, and winged.	HYRIA.	ÆGLIA.
Cylindrica.	Shell excessively lengthened; teeth crenated.	IRIDINA.	MYSCA.
Pustulata.	Oval; winged; summits very small.	ANODON.	LYMNADIA.
Plicata.	Lateral teeth and cardinal teeth variable.	ALASMODON.	POTOMIDA.

Thus we find that every thing apparently anomalous in *T. cylindrica* is at once explained by its being the link between *Ligumia* and *Theliderma;* for if a shell so formed had not been discovered, this link would have been wanting. It has been stated that the *crassidens*, *Peruviana*, and *rariplicata* of Lamarck, the *undulatus*

and *crassus* of Barnes, and the *undulata* and *Dombeyana* of Valenciennes, are varieties of Le Sueur's *plicatus;* but as no proofs, so far as we know of, have been brought forward for this opinion, we must withhold our belief from it, — more especially as the same author esteems the *Unio sinuata* of Lamarck the same as the *Mya margaritifera* of Linnæus, and the *Alasmodonta arcuata* of Barnes. These three shells are now before us; and we consider them not only of difierent species, but actually of different genera: the first is a *Unio*, and one of the types of *Potomida;* the two latter are distinct species of *Alasmodon*. Furthermore, Lamarck has not given the name of *sinuata* to the *margaritifera* of Linnæus; for he expressly calls the latter shell, which, we believe, is peculiar to England, *Unio elongata*. We are not fond of adverting to errors; but where they have been committed by writers who, on many points, deserve honourable mention, it is absolutely necessary to show the fallacy of the principles of arrangement from which they have originated.

(257.) On the remaining sub-genera of UNIO — namely, *Cunicula, Ligumia,* and *Megadomus,* our remarks must be very brief. The first is at once distinguished by the compression of the summits or bosses, and by being always more or less angulated on the posterior slope: *planulata, cuneata,* and *rubiginosa* are typical examples, having the lower lateral tooth remarkably thick, — the singular *foliacia* of Say obviously representing the *Unio cornutus;* Lamarck's *purpurata* seems to lead immediately to the sub-genus LIGUMIA, where the general form of the shell is nearly as much elongated as any of the IRIDINÆ. We consider Lamarck's *recta* (*fig. 55.*) as the type, although we think this is also the place for the *gibbosa* and other elongated species, whose outer cardinal tooth is not erect, and both teeth more in unison with those of *Cunicula* and *Unio*. In all these the shape and direction of the cardinal teeth are quite different from

* Lea on the Genus *Unio*, Am. Trans. vol. iii. N. S. 1829.

Mysca, which they nevertheless represent by their pod-like form. The remarkable *T. cylindrica*, already noticed, unites to this form the tubercles of the sub-genus Theliderma, which has just been analysed.

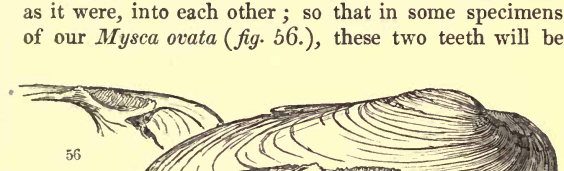
(258.) There seems strong evidence for believing that our *Unio gigas* follows Theliderma; in which case it may be regarded as the type of a distinct sub-genus, which, for the present, we shall name Megadomus. It differs from the *T. Peruviana* and its allies, by having only one lateral tooth in each valve; and the bosses are remarkably small and compressed. We have already alluded to the disappearance of one of the cardinal teeth in an aberrant species of *Theliderma;* and we can now notice a second gradation in an enormous large and very old shell, intimately resembling *plicata*, but having the second lateral tooth in one valve reduced to a mere vestige. The question is, whether this deficiency is accidental or permanent: all such deviations from the typical characters of the Unioninæ, particularly in their teeth, we regard as prototypes of the Alasmodontinæ; but their natural location is very difficult, particularly until the question regarding Potomidea being a genus, or a sub-genus, is decided.

(259.) Æglia, the second genus, is the representative of *Hyria:* this is apparent in the general form of their shells, and in the structure of the cardinal teeth. The posterior half is very thick and truncated, so as to form a carinated angle; the bosses approach towards the centre, and are very prominent; the form is thus almost equilateral, and consequently the lateral teeth are

unusually short; the cardinal teeth are also very peculiar, as already explained (*fig.* 47. *b*); the groove between them diverges from the beak in precisely an opposite direction to that which separates the lateral teeth, —in other words, it is obliquely parallel to the margin of the shell, instead of receding from it. In the comparative size of these teeth there is also a decided difference: in *Æglia,* the inner cardinal tooth is the smallest, while in *Unio* it is the largest. The typical examples are *Æ. ovata* (*fig.* 49.), *cuneata* Sw., and *occidens* Lea. Unfortunately, however, the genus is not so rich in forms as the last, and hence the links between the sub-generic types are not so beautifully graduated; but the three species above named are certainly typical, and by means of *ventricosa, ater,* and *siliquoides,* lead us to the confines of the group, where we find such species as M. Say's *cariosus* and *ochraceus,* among which, and some kindred species, there is at present much confusion: these, however, conduct us to the *U. radiatus* of the American conchologists. This is a very remarkable shell, because it seems the point of junction between *Æglia* and the next sub-genus (*Mysca*); the form of the teeth are consequently very variable: hence we find that, in some varieties of this species, the teeth are like those of *ochraceus;* in others, the cardinal teeth are nearly equal, as in Mysca; and in a very old specimen now before me, the inner tooth is actually the largest. These are all natural variations, and are accounted for upon the principle that osculent groups or forms vary according to the characters of those other forms which they connect. Lastly, we have a beautiful prototype of *Theliderma* in *Canthyria,* the type of which is the *U. spinosus* of Lea. This, and *Naidea,* are the only sub-genera we shall venture to characterise; the other two requiring much more study than we have yet been able to give them.

(260.) The sub-genus Mysca follows next, and obviously blends into the last. *Mysca* is the representation of *Iridina;* and we consequently find that nearly all the

species are unusually long and narrow, while their interior lustre is by far more brilliant and iridescent than in either of the preceding groups. The cardinal teeth, although in some respects like those of *Ægilia*, nevertheless deserve much attention, because they not only differ from those of *Unio* and *Ægilia*, but bear a remote analogy to IRIDINA. They are the most crenated of all those in the UNIONINÆ, precisely as those of *Iridina* are the most crenated in the entire family: they are likewise the most parallel to the anterior margin; and although in general distinctly divided, they yet have a propensity, even in individuals of the same species, to unite, and run, as it were, into each other; so that in some specimens of our *Mysca ovata* (*fig.* 56.), these two teeth will be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perfectly divided; while in others of a younger age, from the same pond, the division will be only marked by an indentation on the ridge, — the groove itself being almost obsolete. Now, this is precisely in unison with shells intended to represent *Iridina*, where the lateral and cardinal teeth are united into a crenated line. This variation in shells of the same species is not only perplexing to young conchologists, but to more experienced ones: in general, however, we may consider it as a rule that no *Unio* belongs to this group, which has the cardinal teeth thick and obtuse; nor does it comprise any in which one of the cardinal teeth is not immediately beneath the bosses. These positive and negative characters render the discrimination of *Mysca* comparatively easy. Very

fortunately, the group, although not so extensive as the first, is yet rich in subordinate types; we shall, therefore make some approximation to the natural series of the species, by looking to the following table, wherein each subordinate type is indicated by its most prominent example.

Analogies of the Sub-generic Types of MYSCA.

Types.	*Analogies.*	Genera of *Unionidæ.*
Mysca ovata.	Both cardinal teeth present, short, and jagged; one in the left valve.	UNIO.
marginalis.	Two nearly equal cardinal teeth in the left valve.	HYRIA.
nasuta.	Outer cardinal tooth nearly erect, pointed, somewhat conical.	IRIDINA.
Nilotica.	Oval; hinge sub-connate; posterior angle winged.	ANODON.
fragilis.	Hinge sub-connate; cardinal teeth imperfect.	ALASMODON.

(261.) Among the longest species of *Mysca* generally known are our two British species, *ovata* and *pictorum*, which may consequently be considered typical; and these also have the most crenated cardinal teeth. Following these we have a type from India, represented by the *marginalis* of Lamarck, where the outer cardinal tooth is long and slender, as in *Hyria;* and the other similarly formed, but much shorter: these shells are also remarkable for having two distinct cardinal teeth, almost alike, in the other or left hand valve, — a structure which is quite different from that of *ovata*, and indeed of all other *Unionidæ*. Let the malacologist examine the *Hyria avicularia* and the *Unio marginata* of Lamarck; and so far as regards the cardinal teeth, he will find they are formed precisely on the same model: nothing, therefore, can be more perfect.* *Marginalis* agrees also with *Iridina*, in being, without exception, the most iridescent

* We even question whether this may not be a relation of affinity, and thus Lamarck's *marginata* may be the anodontine type in *Hyria*.

of the group: with *marginalis* must be joined three or four other species, all of which are from China and India. One of these now before us, bears such a close resemblance to the *Unio nasutus* of Say, that, if the teeth are not examined, it would be impossible to define their difference. *Nasutus*, however, represents another type, which at present is almost exclusively confined to North America. Here the cardinal teeth greatly resemble those of Say's *cariosa* and *radiata* (which come into the circle of ÆGLIA); for the outer one is somewhat conic and erect, while there is only a single defined tooth in the left valve. From *nasuta* we pass, by several intervening species, into the next type, represented by our *M. Nilotica*, shaped like a small *Anodon*, but with the teeth of *Mysca*. We possess three other species, all from the river Nile, and believe there are many others. Finally, we have from America the *Unio fragilis*, figured very accurately in our *Zool. Illust.* 1st Series, pl. 171., but which the American conchologists do not appear to understand: it truly belongs to their genus *Unio*, because the two lateral teeth are well defined, although the cardinal are but slightly developed. Our figure, nevertheless, was drawn from a very old specimen, which did not exhibit the elevated and angulated posterior margin. Now, of all the *Unionidæ* so constructed, this makes the nearest approach to the well-known *Unio alata* of Lamarck; while, in the imperfection of its teeth, it clearly represents *Alasmodon*. We are thus brought round to the group with which we commenced; and were it necessary to point out the precise point where the circle is closed, we could expatiate upon the structure of our *M. Mexicana*, — an undescribed species, and standing intermediate between the first type and the last. It must not be supposed that the modifications of form represented by the five species named in the last table, are merely confined to one or two examples; even our own collection of specimens and of drawings can produce several. *Ovata*, for instance, represents a little group of eight species; *marginalis*, another of four; *nasuta*, seven; *Nilotica*, four; and

fragilis, two. Now, when we reflect how many more may be in cabinets, and the probability of still greater numbers being undiscovered, we should be fully waranted in designating these sections as sub-genera; but so long as any doubts remain regarding the true affinities of our sub-genus *Potomida*, this plan may be suspended.

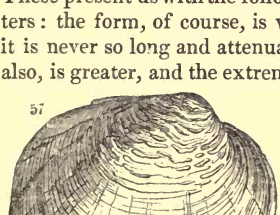
(262.) The *Lymnadia alata* is one of the most remarkable shells of this sub-family; not so much on account of its beauty, but as holding a more isolated station than any yet noticed. That it has a strong resemblance to *Anodon*, is indisputable; but that it has a much stronger one to the *Unioninæ*, cannot be questioned. — Now, every one who draws the distinction between analogy and affinity, immediately perceives that the first of these resemblances is purely analogical; while the other, as Lamarck, Say, and Barnes have correctly judged, is one of absolute affinity: it is needless, therefore, to discuss this matter further. At present, *Lymnadia alata* (*fig.* 48.) stands almost alone as the representative of that sub-genus which typifies the anodons. In conformity with this analogy, we find the posterior dorsal margin remarkably elevated, dilated, and *winged*. The ligament also is connate,—that is, entirely covered by a prolongation of the testaceous substance of the valves: the bosses small, and the shell itself oval and depressed. The cardinal teeth are very peculiar: they are compressed and crenated like those of *Mysca;* but the inner one is generally the largest; and the direction of the groove which separates them, is either perpendicular, or diverges from the anterior margin of the shell. It is clear that our *Unio fragilis** either enters in this group or is at the confines of the last: the next question is, what others can be arranged in the same genus with *Lymnadia?* We entertain little doubt that the *Symphynota compressa* of Mr. Lea is one of these.† In this curious type, the cardinal and the lateral teeth are perfect, and it has the complete external aspect of

* Zool. Ill. 1st Series, pl. 171.

† We only know this from the very excellent description and figure in Mr. Lea's paper.

Anodon: it is also so perfectly connate, that Mr. Lea, looking only to that circumstance, actually places it close to *L. alata.* It is nevertheless a distinct type, and seems to represent *Anodon* in this sub-genus: the cardinal teeth, in short, strengthen us in the belief that *Potomida* succeeds to *Lymnadia.* We shall therefore introduce it here, leaving its natural affinities still open to future inquiry.

(263.) In regard to the shells provisionally placed in the genus POTOMIDA, we have some doubts. We feel almost convinced that the types do not belong to the genus *Mysca;* and yet some of the aberrant species approach so closely to such shells as *M. pictorum* and *ovata,* that the gradation, to ordinary eyes, appears perfect. We have one or two species from Brazil, and others from North America, but most of the types seem to be European These present us with the following distinguishing characters: the form, of course, is variable in the species; but it is never so long and attenuated as *Mysca;* the breadth, also, is greater, and the extremities more obtuse. The typical species, *P. corrugata* (*fig.* 57.), is nearly as round as the generality of the Venus-shells: the cardinal teeth are always *two,* — not thin, lengthened, and compressed as in *Mysca,* but thick, short, and strong, so as to resemble the true American unios; like these latter, also, the *inner* cardinal tooth is decidedly the largest — but then they are divided like those of MYSCA and ÆGLIA. The size of the teeth, with the general shape, and robustness of the shell, induce us to think that *Potomida* is not naturally associated with either *Mysca* or *Unio.* The *littoralis* of Lamarck, common in the rivers of France, will show all these characters; but in another Continental species, the *Unio sinuata* Lam., the form is more lengthened; and by the direction of the cardinal cleft, this shell seems to approximate still more to the typical *Unios.* Next we have the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Unio batava of the same country, where the teeth begin to resemble those of *Mysca;* but they are still short, strong, thick, and distinctly separated. Proceeding thus in the natural series, without caring to circumscribe our groups by arbitrary characters, we come to *P. Sicula* (*fig.* 58.), a new species, found by us in the lakes of Leontini in Sicily: here we have a still nearer approach to *Mysca* than what is made by *Batava:* the form of the shell, indeed, is that of *Mysca ovata;* but the teeth are still thick, and the inner one still preserves the typical character of being thicker than the other. The *P. elongata,* also from Sicily, would seem to complete the union of this sub-genus with *Mysca.* Whether we are to look to this as the union of the three aberrant genera of the *Unioninæ* into one circle, or to take it as presumptive evidence that these shells form only a division of *Mysca,* is uncertain. The question is, are they really distinct types? If we merely look to *Mysca pictorum* or *ovata,* and *Potomida litoralis* or *corrugata,* the difference is very remarkable; but on placing between them *Potomida Batava, Sicula,* and *elongata,* the extreme differences are softened down, and we become doubtful as to the limits of the group.* There are several North American shells which we suspect will clear up this point, and hereafter enable us to discover the true typical characters.

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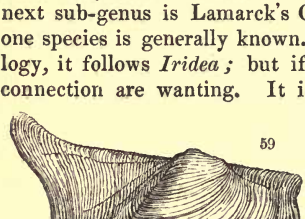
(264.) The Hyrinæ constitute a small but very distinct sub-family, remarkable both for its characters

* Our collection of *Unionidæ*, upon which these remarks were founded, has unfortunately passed into the hands of others, and prevents us from again investigating this question. We shall feel particularly indebted to those conchologists of America who study the *Unionidæ*, for specimens, accurately named, from their "Western Waters," of all the species they can part with, promising to return others in exchange, from New Zealand. Letters and parcels should be directed to us, to the care of John Willis, Esq., Liverpool.

and its geographic distribution. All the species yet known, are from the rivers of Tropical America and Australia,—not one having been found north of the line. Indeed, it may be almost said that the range of the genus *Unio* is bounded by the same latitudes; for of all the UNIONINÆ we have yet seen, not more than two have been brought from South America, and these do not belong to the most typical groups. The HYRINÆ are distinguished by the angulated or wedge-shaped form of the shell, and the winglike projection of its hinge or dorsal extremities. The second character is in the narrow linear form of the cardinal teeth, which are on one side of the bosses, not *beneath* them: these teeth also diverge to the anterior edge, and are always more or less linear. The third character is so very simple and constant, that it may be recognised by the merest tyro; the bosses or summits of the valves are wrinkled or grooved *transversely;* that is, in a line from the apex to the basal margin. This singular peculiarity, which pervades nearly all the types we have yet seen of the HYRINÆ, is directly opposed to the characters of the UNIONINÆ, where, if the summits are wrinkled, the wrinkles are placed *longitudinally,* or in a direction from the anterior to the posterior extremities. In what way this may be connected with the natural habits of the animals, is totally unknown.

(265.) The passage from the UNIONINÆ to the HYRINÆ is through *Mysca* in the former, and *Iridea* in the latter. The gradation from one to the other is beautifully perfect. *Iridea* has the strongest possible affinity to *Mysca*, in the general shape of the shell, and in the structure of the cardinal teeth: the form, however, is more oval than elongated; the ends more obtuse; the posterior end of the hinge margin more elevated, and the summits smaller. These, however, are points of inferior moment. The chief distinction is in the length and narrowness of the outer cardinal tooth, and the almost total absence of the other: hence it is, that in such shells there are always two distinct

cardinal teeth in the *left* valve; whereas, in the UNIONINÆ, this valve has scarcely ever more than *one*. When, however, both are present in the right valve, the inner one is always *under*, and not on the same line or on the side of the outer tooth. The most aberrant species of *Mysca* have something of this appearance, not very apparent to young conchologists. But there is another and a more easy discrimination. Of thirteen species of *Iridea* now before us, each and all have the bosses or umbones wrinkled transversely, as in *Hyria*. We cannot, indeed, expect that every species will be so marked, for then there would be an absolute line of demarcation between *Iridea* and *Mysca*, which is contrary to nature; but the facts now stated will enable any one to discriminate the two types. The next sub-genus is Lamarck's CASTALIA, of which but one species is generally known. Reasoning from analogy, it follows *Iridea;* but if so, the minor types of connection are wanting. It is a cockle-shaped shell, nearly equilateral, and bears a strong resemblance to *Æglia cuneata*. From this rare and somewhat isolated type the transition to *Hyria* (*fig. 59.*) is rendered easy and natural by means of *Hyria corrugata* Lam.; and *Hyria elongata* indicates a passage to that elongated form which has not yet been discovered, and which must represent either *Alasmodon* or *Iridina*. Such a shell we remember to have once seen at King's Auction-rooms, but by some accident neglected to take notes, or to secure the specimen. In the sub-genus *Naïa*, which we arrange under CASTALIA, we have a form connecting the *C. cordata** with *Iridea*. We have before us six



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* I use the prior specific name of Humphrey rather than Lamarck's *ambigua*, which throws an unnecessary doubt on its being a species.

species, four of which are from India, and two from Australia. They are short, roundly oval shells, with the umbones well defined, and placed towards the middle: from this results their peculiar character. The lateral teeth are short, and not a great deal longer than the cardinal teeth; these latter being strong and thick, without being short: they are much crenated, yet without any ridge; so that they have the appearance of being broken off. Their immediate affinity to *Iridea* is proved by the *Naïa elongata*, from New Holland, having the form of one type, and the teeth of the other. This interesting species, once the property of admiral Bligh, was purchased by us at his sale. The peculiarities of Lamarck's *Unio Australis* (*Hyridella* Sw.), and its affinity to *Iridea*, lead us to arrange it as the anodontine type of the HYRIANÆ, although it may possibly be an aberrant example of *Iridea:* the bosses, however, are not striated, and the whole shell has very much the aspect of an *Anodon*. Of the fifth type, connecting this sub-family to the next, we know nothing more than what has been already stated. As the remaining genera of the *Unionidæ* are neither rich in the number of their forms, nor abundant in their species, we shall mention them with more conciseness.

(266.) According to the views here taken of the HYRINÆ, we may thus compare the four genera, just defined, with the circle of the UNIONINÆ.

Analogies of the HYRINÆ *and the* UNIONINÆ.

Genera of the *Hyrinæ*.	*Analogies.*	Genera of the *Unioninæ*.
CASTALIA.	Shell trigonal; posterior side truncate and short.	ÆGLIA.
HYRIA.	Posterior side lengthened.	UNIO.
——	?	POTOMIDA.
HYRIDELLA.	Compressed, broad; bosses not striated, retuse; teeth slender.	LYMNADIA.
IRIDEA.	Lengthened oblong; bosses small; inner cardinal teeth very small, almost obsolete.	MYSCA.

The type which we consider unknown, is that which leads immediately to IRIDINA, and would consequently be deficient in some of the teeth. The other four are such obvious representations of their prototypes among the UNIONINÆ, that we need not detain the reader by any additional remarks.

(267.) Of the IRIDINÆ, only three typical species have been yet discovered; and these, we believe, are all from the river Nile. (*I. elongata, fig.* 60.) The form of the whole group has been before stated; the shell is almost of equal breadth throughout, with the posterior end nearly, if not quite, as broad as the anterior. This great elongation of the shell must extend, of course, to the animal; and for this reason we admit into the genus *Iridina* a singular shell from the same river (*Iridina Nilotica* Fer.), but which has the hinge line only "slightly crenulated at the umbones."* Here it is that Nature, as it were, is hovering between the confines of this type and the *Anodontinæ*, and plainly intimates to us which will be her succeeding group.

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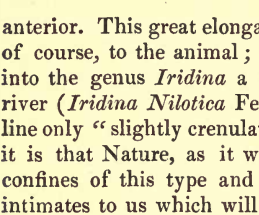

(268.) The ANODONTINÆ form a more numerous sub-family than the two last. Tropical America appears richer in these shells, than any other part of the world. Although one of the sub-genera is peculiar to Asia, the typical form (represented by our common *Anodon anatinus*) occurs both in Europe, Asia, and North America, but under different modifications, which will render it necessary to distinguish them as sub-genera. We arrange the whole under the five principal genera of *Lamproscapha* Sw., *Symphynota* Lea, *Anodon* Lam., *Hemiodon* Sw., and *Patularia* Sw. The first of these contains such shells as the *A. ensiformis, siliquosum*, &c.†, which have the shape of *Iridina*, but are

* Zool. Journ. i. 55. The name of *Pleodon* cannot be substituted for that of *Iridina*, as applied to the typical species.

† From Brazil, figured in Spix and Martius's *Testacea Fluviatilia, &c.*, published in 1827.

destitute of any crenations, or plate, below the hinge margin. These obviously lead to *Symphynota*, where the form is oval and winged; while a slender lamellar tooth extends the whole length of the shell. Following this we have the typical genus *Anodon*, where the plate in question is entirely wanting. There are many striking modifications, however, in the form of these shells, which may hereafter point out the sub-genera: — in *Anodon* proper, the form is transversely oval or oblong, and the bosses very small and compressed: *Patularia* has the umbones remarkably swollen, or ventricose; and the shell almost round: lastly, the genus *Hemiodon* includes those which have a slight tubercle, or indication of the cardinal teeth; thus leading to the ALASMODONTINÆ.

(269.) Assembling these types in a tabular form, we shall find they possess the usual analogies.

Analogies of the Genera of the ANODONTINÆ.

Genera of the *Anodontinæ*.	*Analogies.*	Sub-families of *Unionidæ*.
ANODON.	Pre-eminently typical.	UNIONINÆ.
SYMPHYNOTA.	Hinge margin or teeth lamellar.	HYRIANÆ.
LAMPROSCAPHA.	Boat-shaped, and very long, no teeth.	IRIDINANÆ.
PATULARIA.	Shell nearly round; no teeth.	ANODONINÆ.
HEMIODON.	Hinge plate sinuated or tuberculated.	ALASMODONINÆ.

Not having carried our analysis into the sub-genera, we shall not venture to name those which have the aspect of being such. It is plain, however, that there are aberrant species, if not sub-genera, in *Symphynota* and *Anodon*. These two are probably connected by *Anodon rubra*, which has a distinct elevated ridge, analogous to the lamellar tooth of *Symphynota*. The bosses, again, of our common *Anodon* are small and compressed; while those of *A. trapezialis* Lam., and other large species, are remarkably ventricose. The *Anodon purpurascens**,

* Zool. Ill. pl. i. 260.

again, has the rudiments of a very thin and short lateral plate. It may be proper to observe in this place, that *Dipsas* was the original name imposed by Dr. Leach to this sub-genus; but Larentini, so far back as 1768, had given this name to a genus of reptiles: and as this is an insuperable bar to its repetition, we gladly adopt that of *Symphynota* Lea, under the restrictions here mentioned.

(270.) The last sub-family is that of the ALASMODONTINÆ, the typical species of which are all from the rivers of America. They are connected to the anodons, in the most graduated and perfect manner, by our genus *Hemidon;* and the first type is probably represented by the *Unio calceola* of Lea: then follows the typical form, as seen in Say's original *Alasmodon undulata* (*fig.* 61.); our genus *Uniopsis* appears to succeed this, then we have the elongated form in Schumacher's *Margaritana;* and, finally, the anodoniform, or most aberrant type, is seen in our *Complanaria gigas* and *rugosa.** The whole of these constitute one of the most natural divisions in the family. Typically considered, they are without any distinct lateral teeth; the hinge-plate being either long and merely convex, as in *Margaritana;* or short, flattened, and obliquely grooved, as in *Complanaria.* The cardinal teeth are always present, but vary in each type; hence they furnish an admirable clue to the analogies of the genera. Nothing appears known of the animal; but this is not material to our present purpose, since the variation of the shell is quite sufficient to guide us in their natural

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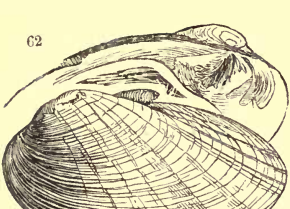
* Mr. Lea, in his artificial arrangement, places these two shells in widely different divisions, because one, he says, is "symphynote," and the other "*non*-symphynote:" they are the *Alasmodonta complanata* and *rugosa* of American writers, and are most naturally connected.



arrangement. The exceedingly oblique teeth of our *Uniopsis radiata** (*fig.* 62.) show it is the prototype of *Unio*, and might have been there placed, but for the want of lateral teeth. The triangular and cuneated shape of *Alasmodon undulata* reminds us of *Æglia*. The single cardinal tooth of *Calceola truncata*† accords with the tubercles of *Hemiodon;* while the compressed bosses and dilated posterior side of *Complanaria* preserves the analogy between this sub-genus and its prototypes *Lymnadia, Theliderma,* and *Anodon*. Finally, we come to *Margaritana,* which, every one must perceive, puts on the aspect of *Mysca, Ligumia, Potomida,* and the *Iridinæ*. Whether the whole of the shells retained by us in this last genus really enter into the circle we are at present tracing, or that such as have an obsolete lateral tooth should naturally be arranged with the *Potomida littoralis*, &c., cannot, of course, be yet determined; nor do we feel certain that *Calceola* is the connecting type with the *Anodontinæ*. And yet, as all these find their representatives in the leading divisions of the UNIONIDÆ, they become absolutely types of genera, equivalent in rank, although not in numbers, to the genera of the sub-family UNIONINÆ. This will be further apparent from the following exposition:—

* I suppose, from the name, that this is the *Margaritana radiata* of Lea's Synopsis, but, as no reference is made to where the shell is described, or any information beyond its being "non-symphynote and smooth," I affix this name at a venture, merely for my present purpose; the real name, if described, can always be made out from the figure here given. Since writing the above, my kind friend Mrs. Corrie (who has a noble series of *Unionidæ* in her fine collection) has sent me a specimen of this type under the name of *Alasmodon inflata;* the teeth are not near so oblique as in that here figured.

† Under the common name of *Unio calciolus*, we have received three distinct species from America.

Analogies of the Genera of the ALASMODONTINÆ.

Genera.	*Analogical Characters.*	Sub-families of the *Unionidæ*.	Genera of *Unioninæ*.	Sub-genera of *Unio*.
Uniopsis.	Inequilateral; the cardinal teeth receding from the anterior margin.	UNIONINÆ.	UNIO.	*Unio.*
Alasmodon.	Cuneate, and nearly equilateral.	HYRINÆ.	ÆGLIA.	*Cunicula.*
Calceola.	?	ALASMODONINÆ.	POTOMIDA.	*Megadomus.*
Complanaria.	Winged; the bosses small and much compressed.	ANODONTINÆ.	LYMNADIA.	*Theliderma*
Margaritana.	Oblong oval, greatly lengthened.	IRIDINÆ.	MYSCA.	*Ligumia.*

(271.) Having brought our rapid exposition of this family to a close, we may now offer a few general remarks upon the whole. The *Unionidæ*, of all the groups of the DITHYRA, is that which contains the greatest modifications of form; insomuch that it becomes almost impossible, in some of its minor divisions, to determine which are species, and which varieties. Hence has originated the idea, entertained by several conchologists, that they constitute but a single genus; while others have gone so far as to suspect that there is in reality but one species of *Unio*, and "perhaps of the whole family:" such, at least, were the sentiments entertained some years ago, although we believe they no longer exist. Upon this principle, the equally extensive and varied family of *Helicidæ* should form but one genus, or rather but *one* species, which might be called *Helix* or *Limax terrestris*, because it lived upon land.* It is useless to prove, that by this false and vicious sort of generalisation, we should return back to

* The naked slugs and the land snails pass into each other by such graduated shades, that no "well-marked and absolute characters" can be found to separate them.

the dark ages of zoology, and produce the same sort of confusion and ignorance which then reigned. But, then, it may be asked, how can genera be retained in our systems, which actually blend into each other, and whose distinctions thus become lost? This objection has been repeatedly answered. Genera which are really natural, are always thus united, because they show us all the connecting links of nature. But genera which contain only well-defined and isolated characters, so that no ordinary person can confound them, are not perfect, because their connecting links to others are wanting: they are fragments of the chain, having its gradations disturbed, dissevered, broken; — hence such groups are fragments only of what has been, or may be, a natural assemblage. Our divisions of sub-families, genera, sub-genera, and sections, are mere conventional terms employed to denote groups of different sizes, possessing, in the majority, certain primary characters which are termed typical. It matters not upon what characters these divisions are founded in the *Unionidæ* and the *Helicidæ*, provided none can be drawn from the animal; but it is most essential that disruptions of kindred species should not be made, — for then the harmony of nature is destroyed. Now, this leads us again to advert to the different sorts of resemblances natural objects bear to each other. The confounding of analogy and affinity, which has led to the greatest confusion in every branch of zoology, has been particularly conspicuous in this: every conchologist, for instance, perceives that *Ligumia recta*, *Mysca ovata* and *nasuta*, *Iridina elongata*, and *Alasmodon margaritifera*, have a very strong resemblance to each other. Now, if this resemblance were one of *affinity*, it naturally would follow that all these shells belonged to the same natural group: they possess one character in common, — that of being particularly long, pod-like shells; yet if any methodist, looking to this only, and disregarding all other characters, make them into a genus, he would commit a palpable outrage on natural classification. So, in like

manner, if he took all the winged or connate shells, and, holding as trivial their other characters, proceeded to place them in a separate genus, he would be doing the same thing, — he would be confounding objects which merely represented each other analogically, or, as it were, *allegorically*, under the belief that they were *bonâ fide* connected by affinity, and followed each other in the scale of nature.

(272.) But if all this be admitted, the difficulty of separating species from varieties still remains: a species, it has been said, is the only absolute division in nature; and did we look to the vertebrated, and even the annulose, animals, we might be tempted to adopt this as an axiom; but in regard to the present family, at least, it cannot be maintained, for it receives a direct contradiction. The mode of generation in the whole of the *Dithyra* precludes the theory of promiscuous intercourse, and the consequent production of hybrids.* The variations, therefore, are spontaneous, and lie beyond our investigation. We have seen, however, in the case of the *Unio Mytiloides*, that while Nature appears to disregard all her usual bounds, and to indulge in almost endless diversity, she nevertheless strictly confines herself to the same plan she has pursued in all other groups. Her variations are upon the same system as that which pervades the animal world. She creates, in short, a type, all the variations of which have a reference to, and often the very aspect of, those particular forms which mark the primary divisions of the whole family. This theory, borne out in almost every group here laid before the reader, will materially, if not absolutely, guide us in determining the limits of species, and consequently of varieties. We trust the rising school of American malacologists will confirm this by a renewed investigation of the inexhaustible profusion of *Unionidæ* with which their noble rivers abound. Having seen but very few of

* On all anatomical facts, we look to the illustrious Cuvier as a paramount authority; he expressly says all the *Dithyra* are hermaphrodites. Mr. Lea, however, mentions male and female shell-fish of the same species. Is there no error in this?

the valuable Essays, &c. published in their own country on the species, we have not ventured to carry our analysis so far: our object for the last twenty-three years has been to discover the fundamental principles of their natural arrangement. How far we have done this, time alone will show. Much uncertainty, indeed, hangs over the location of one or two genera; but this, however desirable to be cleared up, affects not the principle itself, — for that coincides with all we know of the universal laws of animal variation.

(273.) Our remaining space is now so contracted, that we can do no more than merely glance at the two remaining tribes of the DITHYRA. The *Branchiopoda*, indeed, have already been slightly noticed (238); while the annexed cut (*fig.* 63.) of Mr. Broderip's CHELYOSOMA

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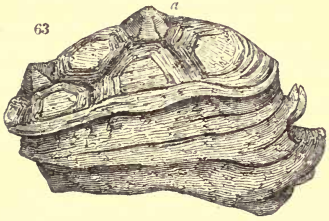

will give a good idea of this most extraordinary animal. According to that very able naturalist, it adheres to stones by coriacious processes from the lower part. It must be observed, however, that on this lower or cup-shaped part, there are *slight* traces of separation into plates, but without internal muscular fibre. The upper surface is flat, and consists of eight coriaceous, somewhat horny angular plates, which are so disposed that the branchial orifice (*a*) is surrounded by three plates, and the anal orifice (*b*) by four: each of the plates are marked by elevated striæ, as in the tortoises. The valves of the orifices are opened and closed by muscles, adhering at one end to the inner surface of the tunic (not of the mantle), and on the other to a small papillary process on

the valves themselves. Besides this set of muscles, and within them, is another set, which passes laterally from one papilla to another. Other muscles enable the animal to contract or dilate itself. The ovaries, viscera, &c., were in too decayed a state for examination; but the mantle appears to adhere only to the orifices, each of which has six valves.* Wherever this animal is placed, its extraordinary analogy to the *Cyclobranchia* and the other cheloniform types, will still be the same; and our present impression is, that it represents the chitons in this division of the order rather than in that of the *Tunicata*.

(274.) Having now completed our exposition of the two great typical divisions of the TESTACEA, in which are included the whole of the univalve and bivalve shell-fish†, we must reluctantly close this part of our volume. The whole of the aberrant orders, as the *Cephalopoda*, the *Parenchymata*, and the *Nudibranchia*, together with the radiated and the coralline Mollusks, will therefore remain open to future investigators of the natural system, and they may possibly form hereafter the subject of another volume supplementary to this.

* Abridged from Zool. Journal, vol. v. p. 46.
† Excepting those of the *Cephalopoda* or Nautilus order.

PART II.

A NATURAL ARRANGEMENT

OF THE UNIVALVE AND BIVALVE SHELL-FISH, COMPOSING

THE ORDERS

GASTEROPODA AND DITHYRA

OF THE CLASS

TESTACEA.

Chief Abbreviations.

Bligh Cat. *Catalogue of the Bligh Shells.*
Chem. or Ch. *Chemnitz.*
Ency. Méth. or En. M. *Encyclopédie Méthodique.*
Lam. *System of Invertebrated animals;* the No. refers to his series of species in the original edition.
Mart. or Mar. *Martini.*
Sow. Gen. or S. Gen. *Sowerby's Genera of Shells.*
Sow. Man. *Sowerby's Manual of Conchology.*
Tank. C. *Tankerville Catalogue.*
Zool. Ill. i. & ii. *Zoological Illustrations, First and Second Series.*

ORDER GASTEROPODA.

TRIBE ZOOPHAGA. *Carnivorous Gastropods.*

FAMILY 1. MURICIDÆ. *Murexes and Whelks.*

Pillar never plaited; shell spiral, the base narrowed, and either truncate or slightly produced.

SUB-FAM. 1. MURICINÆ. *Murexes.*

Spire as long as the aperture; exterior rough; the whorls marked with varices; aperture wide.

MUREX *Lin.* Varices from three to five on each whorl;

inner lip smooth; the spire much shorter than the aperture; an internal groove at the upper angle of the aperture.

Murex Lin. Canal very long; shell armed with acute, cylindrical, tooth-like spines, mostly arranged in three varices.

tenuispina. Sow. Gen. f. 2.
crassispina. Mart. f. 1052–4.
cornutus. Mart. 114. f. 1057.
brandaris. Ib. f. 1050. 1058.

Haustellaria Sw. Canal excessively long; shell without spines; the varices tuberculated.

erythrostoma *Sw.* Sow. Gen. f. 1. (*Murex haustellum* L.)

Phyllonotus Sw. Canal moderate; varices foliated, laciniated, compressed, or resembling leaves (*fig.* 66. *d*).

inflatus. Mart. 102. f. 980.
eurystomus. Zool. Ill. ii. 100.
imperialis. Ib. pl. 109.
cervicornis. Sow. Gen. f. 4.
Scorpio. Ib. f. 3.
calcitrapa. Mart. 102. f. 982.
brevifrons. Ib. f. 983.
axicornis. Mart. 105. f. 989.
endeva. Ib. 107. f. 107, 108. (Aberrant.)
adustus. Ib. f. 990, 991.
trunculus. Ib. f. 1018, 1019.
saxatilis. Ib. f. 1011, 1012.
palmarosæ. Lister. 946. f. 41.
capucinus. Chem. 192. 1849.

Muricanthus Sw.* Varices numerous, foliated; spire short; margin of the outer lip with a prominent tooth near the base.

radix *Sw.* Zool. Ill. 2d series. pl. 113.
melanomathus. En. Méth. 418. f. 2.

Pteronotus Sw. Varices three, compressed, fin-shaped; canal moderate, generally closed by the union of the two lips at their base.

pinnatus. Zool. Ill. ii. pl. 112.
tripteroides. En. M. 417. f. 3.
trigonularis. Mart. f. 1031.
hemitripterus. En. M. 418. f. 4.
tricarinatus. En. M. 418. f. 5.
phyllopterus. Sow. Gen. f. 5.
gibbosus. En. M. 418. f. 1.
acanthopterus. Ib. 417. f. 2.
uncinarius. Mart. f. 1034–5.

Muricidea *Sw.* Spire more produced, as long or

* This type was originally called *Centronotus;* but as that name had been previously given to a genus of fishes, we substitute the above.

longer than the body whorl; varices numerous; no internal channel at the top of the aperture. (*fig.* 65. *c.*)

lamellosa. Chem. f. 1823–4.
magellanica. En. M. 419. f. 4.
peruviana. Ib. f. 5.
senticosa. Ib. f. 3.
scaber. En. Méth. 419. f. 6.
hexagona. Ib. 418. f. 3.
erinacea. Mart. f. 1026.

VITULARIA *Sw.* General habit of *Muricidea,* but the inner lip is depressed and flattened as in the *Purpurinæ;* varices simple, nearly obsolete (*fig.* 65. *e.*)

tuberculata *Sw.* En. M. 419. f. 1. (*Murex vitulinus* Auct.)

TRITON * *Lam.* The varices few, and placed alternately. (*fig.* 64.)

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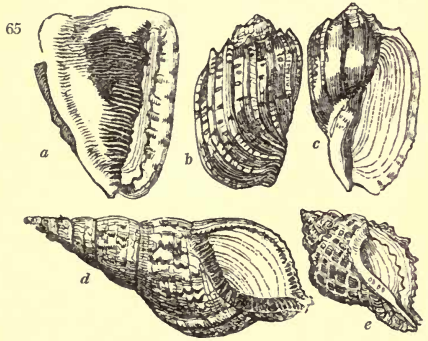
australis. Sow. Gen. f. 1.
lotorium. Ib. f. 1. (*fig.* 66. *e*)
anus. Ib. f. 2. clavator. f. 3.
variegatum. (*fig.* 65. *d*)

RANELLA *Lam.* Varices forming a ridge on both sides of the shell; channel short.

marginata. Sow. Gen. f. 2.
caudisata. Ib. f. 1.
spinosa. En. M. 421. 5.
crumena. Ib. 421. 3.

SUB-FAM. 2. CASSINÆ.

Shell large, ventricose, generally smooth; spire very



* This is the only character by which this group, as a *genus,* can be distinguished; and this is exceptionable, because there are some species, like *T. clandestinum* (*fig.* 64.), which have the outer lip thickened, and are with-

short; the base truncate and emarginate, or with a short recurved channel; inner lip toothed or plaited.*

HARPA *Lam.* Varices numerous and regular, forming longitudinal ribs, coronated near the suture; aperture and lips highly polished; base truncate (*fig.* 65. *b, c*).

multicostata. Sow. Gen. f. 1. crenata *Sw.* Bligh, Cat.

CYPRÆCASSIS *Stuchbury.* Shell oblong, oval, ventricose, without varices; spire very small; aperture cypræiform; outer lip thickened, convex, and advancing on the spire; inner margin regularly toothed; inner lip thickened, convex, and spreading on the body-whorl, without being detached; pillar angulated internally, and crossed by uniformly slender plaits; canal very short, reposing on the body-whorl; aperture very narrow, with a recurved channel above.

testiculus. Mart. f. 375. ? crumena. Mart. 37. f. 379.
rufa. Ib. 32. f. 341. harpæformis. Lam. No. 26.†

CASSIS *Lam.* Shell ponderous, marked with varices;

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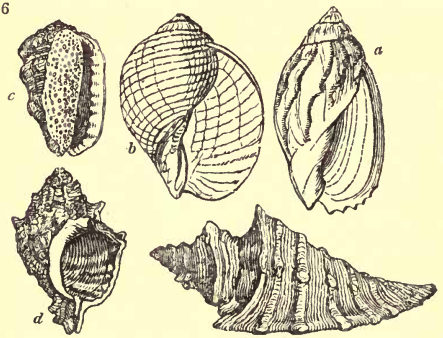


out any varices. There is, in fact, every modification of shape among the Tritons as they now stand; some have the aperture wide, others narrow; the channel is either very long or truncate; the spire greatly lengthened or greatly depressed; the pillar toothed or smooth; the varices either alternate or — none. But, the sub-genera not having been determined, I leave the group in this confused state. These facts, better than any theoretical arguments, show the absolute necessity of defining the sub-genera.

* Except in *Dolium* and *Harpa*.

† Uniting this genus to *Harpa*.

outer lip (typically) considerably dilated, with a prominent, callous, and detached rim; inner lip inflected, broad, flattened, dilated in the middle, and toothed; aperture narrow, irregular. (*fig.* 65. *a.*)

cornuta (type). Chem. pl. 184, 185. (*fig.* 65. *a.*)
tuberosa. Mart. 38. f. 382.
flammea. En. Méth. 406. f. 3. (Aberrant.)
fasciata. Mart. 37. f. 384.

CASSIDEA *Sw.* Aperture wide; outer lip never broad or flattened, but sometimes slightly inflected; inner lip spreading, but never dilated or detached beyond the base into a prominent rim. (*fig.* 66. *a.*)

glauca. Sow. Gen. f. 1.
plicaria. Chem. f. 1459–60.
areola. En. M. 407. f. 3.
Zebra. Chem. f. 1457–8.
decussata. Mart. f. 360–1.
ringens *Sw.* Bligh, Cat.
achatina. En. Méth. 407. f. 1.
pyrum. Lam. No. 17.
zelanica. Ib. 18.
sulcosa. Seba. 68. f. 14, 15.
granulosa. Mart. f. 344–5.
Saburon. Gualt. 39. g.
semigranosa. Lam. No. 23.
vibex. Mart. 35. f. 364–6.
erinaceus. Ib. 35. fig. 363.

DOLIUM *Lam.* Shell ventricose, inflated, smooth; spire very short; outer lip thin, not inflected; base generally truncate and emarginate. (*fig.* 66. *b.*)

D. olearium. Sow. Gen. f. 1. fimbriatum. Ib. f. 2.

SUB-FAM. 3. NASSINÆ.

Generally small; the spire longer than the aperture*; the base either truncate, or with a short recurved channel; inner lip often dilated and spreading; sometimes granulated, but never toothed; a prominent ridge or fold at the base of the pillar; outer lip crenated within.

CASSIDAREA *Lam.* Ventricose; spire short; inner lip spreading, and detached at the base; outer lip thickened within; canal slightly lengthened, and turning upwards; representing *Cassis.*

echinophora. Ency. M. 405. f. 3. Thyrrena. Ib. 405. f. 1.

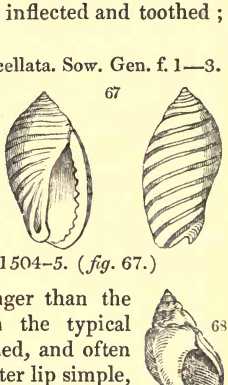
ONISCIDIA *Sow.* General shape of *Cypræcassis,* but less ventricose, the base more attenuated, and the canal

* But in the aberrant genera it is shorter.

truncated; spire very short; both lips thickened, the inner granulated, the outer inflected and toothed; aperture narrow. (*fig.* 66. *c.*)

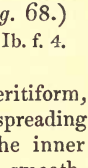
oniscus. Chem. 1872–3. cancellata. Sow. Gen. f. 1—3.

VEXILLA *Sw.* General shape of *Purpura;* the inner lip flattened and depressed; the outer, when adult, thickened, inflected, and toothed; aperture wide.


67

picta *Sw.* Chem. pl. 157. f. 1504–5. (*fig.* 67.)

NASSA *Lam.* Small; spire longer than the aperture; the inner lip, in the typical forms, greatly dilated, thickened, and often with a prominent margin; outer lip simple, crenated; aperture wide, with a groove above; pillar with a basal ridge; base truncate. (*fig.* 68.)


68

N. arcularia. Ency. M. 394. f. 1. clathrata. Ib. f. 4.
papillosa. Sow. Gen. f. 5.

CYCLONASSA* *Sw.* Shell small, depressed, neritiform, nearly round; inner lip forming a vitreous, spreading mass; no internal canal or tubercle on the inner lip; basal notch nearly obsolete; outer lip smooth, entire, thickened.

C. neritea. Ency. M. 394. f. 9. Sow. Gen. f. 3.

SUB-FAM. 4. PURPURINÆ.

Oval; spire much shorter than the aperture, which is very wide; inner lip not defined, but vitreous; pillar broad and flattened; outer lip rarely thickened or inflexed.

RICINULA *Lam.* (*fig.* 71. *d.*) Outer lip dilated, and often forming digitated processes externally, but the margin broad, much reflected, and toothed internally; inner lip flat, broad, generally toothed; spire very small. †

planospira. En. M. 397.5. digitata. Sow. Gen. f. 3, 4.
horrida. Sow. Gen. f. 1. morus. Ib. f. 2.

* The fanciful and inapplicable name of *Cyclops*, given to this type by De Montford, designates a well-known genus of *Crustacea*.

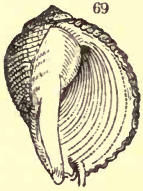
† Except in those species, like *R. morus*, which lead to *Purpura*.

CONCHOLEPAS *Lam.* Patelliform; spire lateral, nearly obsolete; pillar none.

C. Peruviana. Sow. Gen. (*fig.* 71. *a.*)

MONOCEROS *Lam.* Spire moderate; a strong tooth-like process, at the base of the outer lip. (*fig.* 69.)

M. imbricatum. Sow. Gen. f. 1.
cingulatum. Ib. fig. 4.


69

MICROTOMA *Sw.* Pillar very broad and curving inwards; aperture effuse; the notch at the base small, and nearly obsolete; spire very short.

patula. Mart. 69. f. 758, 759. persica. En. Méth. 397. f. 1.
unicolor *Sw.* Chem. f. 1449.

PURPURA *Lam.* Spire more prominent; inner lip flattened; the basal notch wide and distinct.* (*fig.* 70, 71. *b.*)

P. coronata. En. Méth. 397. f. 1.
succincta. Ib. 398. f. 1.

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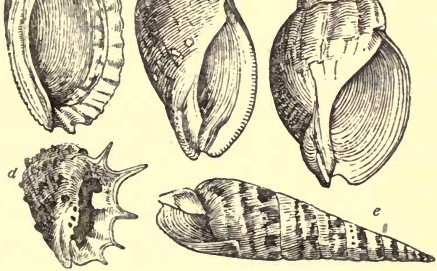
SUB-FAM. 5. BUCCININÆ.

Spire always as long as the aperture, and



* United to *Ricinula* by *P. columellaris*, Ency. Méth. 398. fig. 3., and *Ricinula morus*, Ency. Méth. 395. fig. 6.

typically of great length; base truncated, deeply notched; inner lip smooth, convex.

LEIODOMUS *Sw.* Shell very smooth, nearly polished; spire acute, slender, lengthened; of few whorls; aperture effuse; inner lip thickened and spreading; base of the pillar curving inwards. 8 species.

Achatinum. En. M. 400. f. 4.
vittata. En. Méth. 402. f. 4.
Quoyii *Sw.* Voy. d'Astrol. 31. f. 17.

TEREBRA *Lam.** Shell subulate; spire excessively long, and of numerous whorls; pillar straight; the base curving outwards (*fig.* 71. *e*).

maculata. En. M. 402. f. 4. Babylonica. Ib. 402. f. 5.

BUCCINUM *Linn.* Shell pyriform; spine moderate; body-whorl ventricose; base obtuse, emarginate; lips smooth (*fig.* 71. *c*).

undatum. En. M. 399. f. 1.
? lævigatum. Ib. 400. f. 1.†
lineatum. Ib. 400. f. 8.
papillosum. Ib. 400. f. 2.

TROCHIA *Sw.* Shape intermediate between *Purpura* and *Buccinum*; whorls separated by a deep groove; inner lip, when young, depressed, when adult, thickened, convex, and striated; basal canal very small.

sulcata. En. Méth. 422. f. 4.

TRITONIDEA‡ *Sw.* Shell bucciniform, but the basal half is narrowed, and the middle more or less ventricose; spire and aperture equal. Pillar at the base with two or three obtuse and very transverse plaits, not well defined; outer lip internally crenated, and with

* By this group, the MURICIDÆ are connected with the STROMBIDÆ by means of the *Cerithinæ*.

† Probably an aberrant species of *Leiodomus*.

‡ Mr. Gray has the merit of first publishing this intricate, but most natural genus, which I had many years ago also determined. I should gladly have adopted his name, were it not that *Pollia* has been already given by Hübner and Treitsch to a genus of lepidopterous insects. Mr. Gray has very happily determined what is certainly its true station in the natural system, — that is, intermediate between *Triton* and *Buccinum*. It is connected to *Triton* by *T. clandestinum*, Ency. Méth. 433. fig. 1. (*fig.* 64. p. 297.), which thus completes the circle of this family.

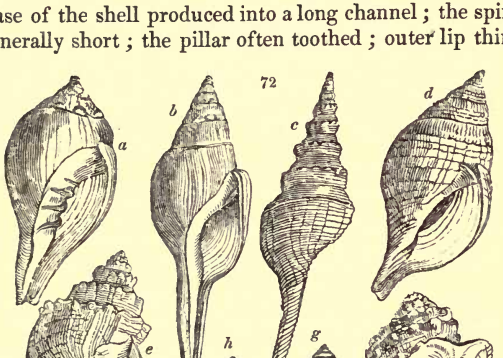
a superior siphon; inner lip wanting, or rudimentary.

undosa. En. Méth. 422. f. 5.
torulosa. Ib. 428. f. 3.
maculosa. Ib. 400. f. 7.

(Aberrant.)
aculeiformis. Ib. 426. f. 3.
articulata. En. M. 426. f. 1.

Family 2. TURBINELLIDÆ.

Base of the shell produced into a long channel; the spire generally short; the pillar often toothed; outer lip thin.



Sub-fam. 1. TURBINELLINÆ.

Spire short, the tip papillary; middle or base of the inner lip plaited; channel lengthened.

Turbinella *Lam.* Shell ponderous, smooth, or slightly nodulous; spire short, papillary; pillar with strong plaits in the middle. (*fig.* 72. *a.*)

rapa. En. Méth. 431.*bis*, f. 1. pyrum. Chem f. 1697, 1698.

Fasciolaria *Lam.* Fusiform, ventricose; spire and aperture of equal length, the former attenuated and

acute; outer lip crenated; base of the pillar with one or two sharp folds. (*fig.* 72. *d.*)

F. tulipa. En.Méth. 431. f. 2. trapezium. Ib. 431. f. 3.

PYRELLA *Sw.* Pyriform; spire very short, papillary; channel lengthened; inner lip flattened, elevated, smooth; pillar with a single sharp fold at the base.

P. spirilla. Zool. Ill. 1st series. En. Méth. 437. f. 4.

CLAVILITHES *Sw.* Unequally fusiform, the body-whorl and spire being conic, and the canal suddenly contracted and attenuated; terminal whorls papillary; inner lip thick; pillar smooth. Fossil only. (*fig.* 72. *b.*)

longævus. En. M. 425. f. 3.
clavellatus. Ib. f. 2.
Noæ. En. Méth. 425. f. 5.
ponderosus *Sw.* Ib. f. 4.

SUB-FAM. 2. SCOLYMINÆ.

Spire more produced, the tip always acute; surface rough; canal short; pillar plaited.

PLICATELLA* *Sw.* Fusiform; the spire produced; pillar with two or three obtuse, basal, transverse folds.

polyzona. En. M. 423. f. 1.
cingulifera. Ib. 429. f. 1.
carinifera. Ib. 423. f. 3.
infundibulum. Ib. 424. f. 2.
craticulata. Ib. 429. f. 3.
lineata. Ib. 429. f. 4.
nassatula. Lam. No. 20.
rustica. Mart. 120. f. 1104.
triserialis. Lam. No. 21.
ocellata. Mart. 124. f. 1160.
variolosa. Lam. No. 22.
tuberculata. Grif. Cuv. 30. f. 3.
turbinelloides. Ib. 25. f. 1.
filosa. En. Méth. 429. f. 5.

SCOLYMUS *Sw.* Sub-fusiform, armed with foliated spires; spire shorter; pillar with distinct plaits in the middle.

cornigerus. Chem. f. 1725–6.
pugellaris. En. M. 401. *bis**, 3.
globulus. Ib. f. 2.
rhinoceros. Chem. f. 1407–8.
ceramica. Mart. 99. f. 943.
capitellum. En. Méth. 431. *bis**, f. 4.
umbilicaris. Ib. f. 1. *a*—*c*.
mitis. Lam. No. 10. p. 106.

* *Polygonum* of some writers; but that is a common and well-known botanical genus of Linnæus, and cannot therefore be again applied.

CANCELLARIA *Lam.* Shell turbinate, scabrous, generally reticulated; body-whorl ventricose; spire and aperture nearly equal; base obtuse; pillar with distinct basal plaits; aperture rather effuse; the canal almost obsolete.

C. reticulata. En. Méth. 375. f. 3. lobata *Sw.* (*fig.* 72. *f.*)

RHINODOMUS *Sw.* No internal groove; shell clavate; the spire longer than, or equal with, the aperture; the whorls with ridges or longitudinal varices, and rendered hispid by transverse grooves; inner lip wanting; pillar with a terminal fold; aperture striated; outer lip with a basal sinus.*

R. senticosus. Chem. tab. 193. f. 1864—1866.

POLYTROPA *Sw.*† Bucciniform; but the base narrowed, and ending in a straight and contracted, but rather short, channel; spire longer or as long as the aperture; exterior folliculated or tuberculated; inner lip flattened, as in *Purpura;* basal notch small, oblique; no internal channel.

crispata. En. Méth. 419 f. 2. Chem. 187. f. 1802. imbricata. Mart. 122. f. 1124. ? rugosa. Chem. f. 1473-4. lapilla. Pennant, pl. 72. f. 89.

SUB-FAM. 3. EBURNINÆ.

Shell generally grooved round the suture; body-whorl ventricose; spire rather longer than the aperture; the base obtuse, and almost entire; inner lip much thickened; outer lip sinuated.

CYLLENE *Gray.* Small; shape of *Harpa* and *Harpula;* shell longitudinally ribbed, and sub-coronated with

* Analogous to *Nassa;* but the inner lip is not developed, and there is not a superior or internal canal: it likewise represents *Leiodomus* by its animal, *Scalaria* by its varices, and *Terebra* by it spire. There are several species with shorter spires than *senticosus*.

† This is an obvious representation of *Purpura* and *Pyrula* in this circle, and is connected to *Plicatella* by such aberrant species as have two or three obsolete tubercles at the base of the inner lip, and a row of others, more distinct, on the opposite side; but even in these the pillar is always depressed, and the channel short. These species are chiefly from the Northern and Southern Oceans. They are at once distinguished from the *Purpuræ* by having no internal channel at the top of the aperture.

tubercles, sometimes cancellated; aperture striated within, rather effuse, longer than the spire, which is acute; inner lip large, vitreous, spreading; the base finely striated; outer lip with a slight sinus at the base, as in *Rhinodomus;* no internal groove; the suture sometimes channeled and polished.

C. Owenii. Griff. Cuv. p. 41. f. 2.

STRUTHIOLARIA *Lam.* Spire turreted; outer lip considerably sinuated; inner lip thick, spreading; the pillar turned inwards; the basal notch nearly obsolete.

nodulosa. En. M. 431. f. 1. crenulata. Astrol. pl. 31. f. 8, 9.

EBURNA *Lam.* Smooth; sutures generally grooved; spire and aperture about equal; inner lip very thick, partly concealing the umbilicus, and with an upper internal groove; outer lip thin, slightly sinuated; basal notch oblique, small. (*fig.* 73.)

73

E. spirata. En. Méth. 401. f. 2. pacifica. En. Méth. 401. f. 4.

PSEUDOLIVA *Sw.* Shell thick, oval, oliviform, ventricose; spire very short, acute; base with two parallel grooves, one of which forms a notch at the base of the outer lip; suture slightly channeled; inner lip very thick, and turning inwards; aperture with an internal canal. Connects the TURBINELLIDÆ with the VOLUTIDÆ.

P. plumbea. Chem. 188. f. 1806, 1807. (*fig.* 3. p. 82.)

LATIAXIS *Sw.* Shell sub-pyriform, turbinate, and the whorls detached, as if distorted; but the spire flattened at the summit; whorls angulated, and carinated, with a fimbriated undulate ridge; pillar none; umbilicus excessively large and deep; aperture angular; the basal notch nearly obsolete.*

P. Mawæ. Griff. Cuv. pl. 25. f. 4.

* This singular shell I regard as the representation of *Scalaria*, *Vermetus*, &c. in the present group, and as opening a passage to the *Pyrulinæ* by

Sub-fam. 4. PYRULINÆ.

Shell pyriform; the base more or less produced; the spire short and typically flattened; inner lip convex, and perfectly smooth.*

Rapella *Sw.* Shell ventricose, generally thin, almost globose; the base suddenly contracted, and forming a short canal, the channel almost obsolete; umbilicus large, partly concealed by the inner lip.

R. papyracia. En. Méth. 436. f. 1.

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Ficula *Sw.* Shell thin, pyriform; the base lengthened into an elongated channel; the upper part ventricose; spire very small, depressed; inner lip wanting. (*fig.* 74.)

ficus. En. Méth. 431. caudata. En. Méth. f. 1. 436. f. 1. *b*, *c*.

Pyrula *Lam.* Shell strong, pyriform, solid, coronated with spines or tubercles; the base lengthened into a long channel; spire very short, but a little elevated and pointed; inner lip wanting.

P. perversa. En. Méth. 433. f. 4.

Cuma *Humphrey.* Sub-fusiform; spire and base equal in length; inner lip with a central fold.

C. sulcata *Sw.* (See *fig.* 4. p. 87.)

Myristica *Sw.* Sub-pyriform; spire strong, spiny, or tuberculated, nearly as long as the base; umbilicus either partially or entirely concealed; inner lip vitreous, thin; the outer with an internal and ascending canal; the basal channel wide.

hippocastanea. En. M. 432. f. 4.
lineata. Ib. f. 5.
melongena. En. Méth. 435. f. 3.
nodosa. Chem. 1564–5.

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means of *Rapella*. I know it, however, only from the figures above quoted. Mr. Gray's description is confined to these words: "Shell deformed, white; from China." It is obviously related to *Rapella*; while, in its large umbilicus and nearly obsolete notch, it has a greater resemblance to *Eburna* than to any other genus I am acquainted with.

* Except in *Cuma*, where there is a central fold.

SUB-FAM. 5. FUSINÆ. — *Spindle-Shells.*

Shells generally fusiform and slender; the base elongated; the spire lengthened and acute; pillar smooth; outer lip thin.

HEMIFUSUS *Sw.* Unequally fusiform, the spire being shorter than the aperture; shell ponderous, coronated with compressed spines; an internal and ascending canal at the top of the aperture.

colossus. En. Méth. 427. f. 2.
pyrulaceus. Ib. 429. f. 6.
coronatus. Ib. 430. f. 2.
morio. En. Méth. 430. f. 3,4.
carnaria. Ib. 434. f. 3.
cochlidium. Ib. 434. f. 2.

CHRYSODOMUS *Sw.* Bucciniform, but the base produced into a channel shorter than the spire; whorls ventricose; smooth, or nearly so; outer lip thin; inner lip obsolete.

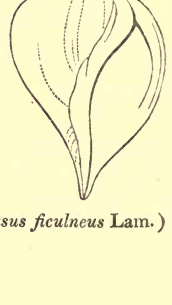
dispectus. Ency. M. 26. f. 4.
argyrostomus. Ib. 426. f. 5.
sulcatus. En. Méth. 424. f. 3.
lignarius. Ib. 424. f. 6.

FUSUS *Lam.* Shell long, slender; both extremities much produced: spire attenuated, turreted, and of nearly equal length with the aperture.

Syracusanus. En. M. 423. f. 6.
torulosus. Ib. f. 4.
incrassatus. Ib. 5.
tuberculatus. En. M. 423. f. 4.
aciculatus. Ib. 425. f. 8.
longicauda. Ib. 423. f. 2.

LEIOSTOMA *Sw.* Equally fusiform, but ventricose in the middle; shell entirely smooth, almost polished; inner lip thickened and vitreous; base of the pillar very straight. Fossil only. (*fig.* 75.)

L. bulbiformis. En. Méth. 428. f. 1.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STREPSIDURA *Sw.* Equally fusiform, but the basal portion of the pillar turned outwardly, with a sharp fold at the base of the aperture; shell costated and sub-coronated; body-whorl ventricose. Fossil only.

S. costata. Sw. En. Méth. 428. f. 2. (*Fusus ficulneus* Lam.)

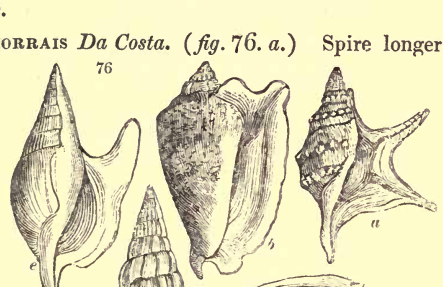
Family 3. STROMBIDÆ. *Wing-Shells.*

Outer lip dilated, or thickened internally, or detached from the preceding whorl by a sinus; operculum small.

Subfam. 1. STROMBINÆ.

Outer lip considerably dilated, but never toothed; spire rarely longer than the aperture, with a sinus near the base.

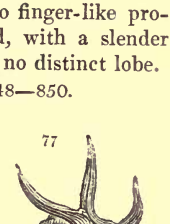
Aphorrais *Da Costa.* (*fig.* 76. *a.*) Spire longer than



the aperture; outer lip dilated into finger-like processes; base produced, compressed, with a slender grooved channel in the middle, but no distinct lobe.

A. pes-pelicani. Mart. 85. f. 848—850.

Pteroceras *Lam.* (*fig.* 77.) Spire short; outer lip considerably dilated, ascending and attached to the spire, in general divided into linear processes; basal lobe inflexed, toothed; channel long.



P. truncatus. Chem. pl. 159.
laciniatus. Ex. Conch. 46. Chem. 158. f. 1506, 1507.
latissimus *Sw.* Mart. 83. f. 835.
purpuratus *Sw.* Chem. 157. f. 1494, 1495.

x 3

STROMBUS *Linn.* (*fig.* 76. *b*) Outer lip entire; the margin not inflected, with a deep sinus near the base, and the upper part not ascending to the top of the spire; basal lobe rarely inflexed, and never toothed.

Pacificus *Sw.* Chem. f. 1485, 1486. Ex. Conch. pl. 17.
melanostomus *Sw.* Ib. f. 1487-8. Ib. pl. 17.
Auris-Dianæ. Mart. f. 838-9.
Lamarckii. Gray?
tricornis. En. Méth. 401. f. 1.
Gallus. Mart. f. 841, 842.
Goliathus. Chem. 195. B.
inermis *Sw.* Bligh, Cat.
gigas. Mart. 80. f. 824.
accipitrinus. Ib. 81. f. 829.

STROMBIDEA *Sw.* Outer lip angulated, but not dilated, or detached from the preceding whorl; upper sinus obsolete, or entirely wanting; the lower distinct.

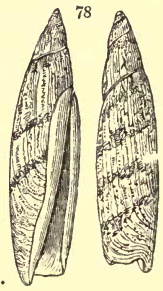
urceus. Mart. 78. f. 803.
plicata. En. M. 408. f. 2.
mutabilis. Mart. 78. f. 807.
tridentata. Chem. f. 1503.
erythrostoma. Ib. f. 1874.
dubia *Sw.* P. Mag. 61. p. 377.

ROSTELLARIA *Lam.* (*fig.* 76. *c, d, e.*) An ascending siphon, formed by a groove thickened on each side, which extends upwards on the spire; outer lip various, but not sinuated at the base.

curvirostris. En. Méth. 411. f. 1. (*fig.* 76. *c.*)
rectirostris. Nat. G. pl. 2. f. 2.
serrata *Sw.* Chem. 195. A. f. 1869.
macroptera. Brander, f. 76.
columbata. En. Méth. 411. f. 2. (*fig.* 76. *e.*)
fissurella. Ib. f. 3. (*fig.* 76. *d.*)
cancellata. Ib. 408. f. 5.
canalis. Ib. 409. f. 4.
decussata. Sow. Gen. f. 8.

SUB-FAM. 2. CONINÆ. *Cones.*

Shell coniform; the spire very short, pyramidical or truncate; outer lip slightly detached above, but without a basal sinus.



TEREBELLUM *Lam.* Cylindrical, smooth; aperture effuse at the base; outer lip with an obsolete sinus; spire either short or concealed.

T. subulatum. En. Méth. 360. fig. 1. (*fig.* 78.)

CORONAXIS *Sw.* Shell conical; the summits of the whorls crowned with a single row of tubercles; mouth of the animal entire.

Coronaxis Sw. Spire truncate, scarcely raised above the margin of the body-whorl, which is not convex.

Bandanus *Lam.* Voy. d' Astrol. pl. 53. f. 7.

Puncticulis Sw. Spire slightly elevated; body-whorl convex near the upper margin; aperture linear; base deeply notched.

P. arenatus *Lam.* Voy. d'Astrol. pl. 52. f. 8.

Tuliparia Sw. Body-whorl ventricose; the aperture effuse.

nebulosa *Sw.* Ency. M. 322. f. 11. (*Conus tulipa* L.)

Cylindrella Sw. Conic-cylindrical; spire elevated, and only slightly coronated on the upper whorls; shell generally grooved.

Asper. Chem. 181. f. 1745-7.

Conilithes Sw. Conic; spire considerably elevated; the aperture linear.

C. antediluvianus. Sow. Gen. f. 1.

CONUS *Linn.* Shell conic; the summit of the whorls smooth; mouth of the animal laciniated.

Conus Linn. Spire generally truncate, or only pointed at the summit; margin of the body-whorl carinate.

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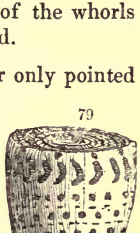

C. millepunctatus. En. Méth. 323. f. 5.
litteratus. Ib. 323. f. 1. (*fig.* 79.)
eburneus. Ib. 324. f. 1, 2.
nobilis. Ib. 339. f. 7.
virgo. Ib. 326. f. 5.
miles. Ib. 329. f. 7.
capitaneus. Ib. 327. f. 2.
vulpinus. Ib. 326. f. 6.
maldivus. Ib. 325. f. 6.
generalis. Ib. 325. f. 2. 4.
monile. Chem. 140. f. 1301—1303.

Dendroconus Sw. Shell heavy; spire lightly elevated;

body whorl convex near the margin; aperture linear.

betulinus. En. Méth. 338. f. 7.
figulinus. Ib. 332. f. 2.
quercinus. Ib. 332. f. 6.
franciscanus. E. M. 337. f. 5.
striatus. Ib. 340. f. 1.
gubernator. Ib. 340. f. 5.
nimbosus. Ib. 341. f. 5.

Textilia Sw. Spire elevated, concave; body-whorl ventricose; the aperture effuse at the base; shell always smooth.

communis. En. M. 346. f. 1—5.
auratus. Ib. 343. f. 1.
rubiginosus. Ib. 344. f. 1, 2.
ammiralis. E. M. 325. f. 1—9.
bullatus. Chem. f. 1315—6.
pyramidalis. En. Méth. 347. f. 5.

Theliconus Sw. Shell narrow, nearly cylindrical, generally grooved transversely; spire elevated, thick, convex, obtuse; aperture linear.

nussatella. Sow. Gen. f. 7. Terebra. Sow. Gen. f. 6.

Leptoconus Sw. Shell light, conic, sometimes striated; spire elevated, acute, concave; the basal whorl carinated, detached, and sinuated above, and contracted near the suture.

grandis. Sow. Gen. f. 2.
amadis. Chem. f. 1322-3.
duplicatus. Sow. Gen. f. 5.
Australis. Ib. f. 4.*

Conella *Sw.* Shell small, conic; spire elevated, smooth; the outer lip advancing a little up the spire; aperture linear; inner lip smooth; outer lip striated within.

picata *Sw.* (*fig.* 17. *a*, p. 151.)

Conorbis *Sw.* Conic, but resembling a *Pleurotoma*: spire conic, considerably elevated; outer lip with a deep sinus above.

C. Dormiter. Sow. Gen. f. 8.

Sub-fam. 3. COLUMBELLINÆ.

Shell small; outer lip considerably thickened within, where the margin is invariably either toothed or striated; the top gibbous, the margin generally inflexed; inner

* Passing into *Nussatella*.

lip doubly toothed, *i. e.* internally and externally; aperture narrow, generally ringent; operculum minute.

CONIDEA *Sw.* Mitra-shaped, fusiform; spire equal or longer than the aperture; the whorls tumid; outer lip slightly gibbous above, contracted below; margin not inflected; striated within; inner lip terminating in an elevated ridge, but with the teeth obsolete.

C. semipunctata. (*Columbella* Lam.) Mart. 44. f. 465, 466.

COLUMBELLA *Lam.* Subfusiform; spire shorter than the aperture; outer lip gibbous, inflected, sinuated, broad, and thickest in the middle, crenated or toothed its entire length; aperture contracted; inner lip with granular teeth.

C. mercatoria. Mart. pl. 44. 452—458.

PUSIOSTOMA *Sw.* General form of *Columbella*; but the outer lip is only toothed in the middle, where it is greatly thickened; inner lip convex between the granular teeth. (*fig.* 72. *g*, *h*.)

punctata. En. M. 374. f. 4. fulgurans. Lam.*
mendicaria. Ib. 375. f. 10. turturina. En. M. 384. f. 2.

CRASSISPIRA Sw. Small, subclavate, tuberculated: spire thick, lengthened; outer lip with a slight sinus above, and thickened internally at the top and bottom; top of the inner lip with a thick pad; basal channel but slightly defined. (*fig.* 17. *a*.)

Pleurotoma Bottæ *Auct.* C. fasciata *Sw.* (*fig.* 17. *d*, p. 151.)

NITIDELLA *Sw.* Bucciniform; small, ovate, smooth, glassy; aperture effuse; outer lip slightly thickened, faintly inflexed, and generally striated internally; inner lip somewhat flattened above; base of the pillar with one or two slight internal folds, or a single angular projection. (*fig.* 17. *e*.)

Columbella nitida *Lam.* (*fig.* 17. *c*, p. 151.)

* Lamarck erroneously cites the Ency. Méth. 574. fig. 7. for this species, as that represents one of his *Mitres*.

Sub-fam. 4. PLEUROTOMINÆ.

Shell turreted, subfusiform; the base channeled, and often much produced; outer lip never thickened, but detached at the top from the whorl by a slit or sinus.*

Brachytoma † *Sw.* Subfusiform; resembling a small *Strombus* or *Fusus;* spire and aperture of equal length; channel short; outer lip slightly ascending, and forming a short canal; sinus very small, and nearly semi-circular; inner lip thickened above.

strombiformis. Sow. Man. f. 381. castanea *Sw.* Chem. f. 1831, 1482.

Pleurotoma *Lam.* Fusiform, turreted; channel lengthened, and nearly as long as the spire; the slit long and narrow; inner lip wanting.

P. virgo. En. Méth. 439. f. 2. Babylonica. Ib. f. 1. Javanica. Ib. f. 3.

Clavatula *Sw.* Spire clavate, very long, turreted; channel short; inner lip wanting.

sulcata *Sw.* Chem. 190. f. 1829.

Clavicantha *Sw.* Thick, sub-fusiform; the surface rugose, and the whorls sub-coronated; channel short; slit assuming the form of a short broad sinus.

C. imperialis. En. Méth. 440. spirata. Ib. 440. f. 5. conica. E. M. 439. f. 9. echinata. Ib. 439. f. 8. auriculifera. Ib. f. 10.

Tomella *Sw.* Fusiform, smooth; the spire of very few whorls, and not longer than the channel; inner lip with a thick callosity at the top; the slit short and wide.

lineata. En. Méth. 440. f. 2. clavicularis. Ib. f. 4. filosa. En. Méth. 440. f. 6. lineolata. Ib. f. 11.

* In the two typical groups, the notch is a long slit; in the three aberrant genera, it forms a wide but short sinus.

† The aberrant species of this genus connects the sub-family with the *Columbellinæ* by means of *Crassispira.* They are mostly small and rare shells.

Sub-fam. 5. CERITHINÆ.

Shell clavate, generally mucronate ; the spire very long ; the outer lip considerably dilated ; the base either truncate, or forming a short recurved channel.

Potomis *Brong.* Fluviatile ? covered with a brown epidermis : whorls coronated, and armed with spines ; aperture almost entire, the notch being slightly developed ; top of the outer lip with an obsolete sinus.

muricata. Sow. Man. 377.* granulata. En. M. 442. f. 4.

Pirena *Lam.* Fluviatile ; smooth ; outer lip much dilated, with a deep narrow slit on the upper part; base widely notched; inner lip entire and thickened.†

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P. terebralis. Sow. Man. f. 316. (*fig.* 80.)

*Terebralia *Sw.* Outer lip much dilated, generally uniting at its base to the inner lip, leaving a round perforation at the base of the pillar ; channel truncate ; operculum round.

palustre. Mart. f. 1472.
sulcatum. En. M.442. f. 2.
Ebenium. Ib. 442. f. 1.
heteroclites. Lam. No. 24.
telescopium. Voy. Ast. pl. 55. f. 4—6.

Rhinoclavis *Sw.* Channel curved backwards in an erect position ; inner lip very thick, with a tumid margin ; pillar generally with a central plait ; operculum ear-shaped.

lineatum. En. M. 443. f. 3.
vertagus. Ib. f. 2.
subulatum. Lam. No. 23.
fasciatum. Mart. 157. f. 1481.
obeliscus. En. Méth. 443. f. 4.
aluco. Ib. f. 5. (Aberrant.)
semi-granosum. Ib. 443. f. 1.
asperum. Mart. 157. f. 1483.

Cerithium *Lam.* Channel short, nearly straight ; pillar smooth ; inner lip thickened only at the top, where

* Connecting this with the last sub-family by means of *Clavicantha.*
† Representing *Pleurotoma.*

it forms a short internal channel; operculum ear-shaped.

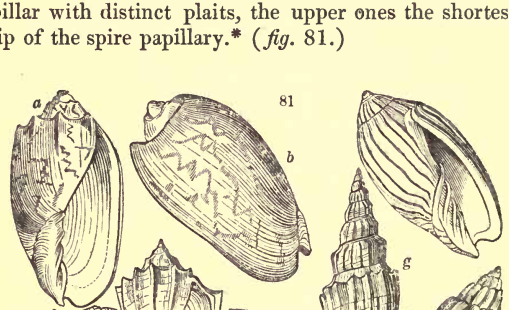
nodulosum. En. Méth. 442. f. 3. tuberculatum. Mart. 157. f. 1490.

Family 4. VOLUTIDÆ.

Shell destitute of a channel; the base truncated and notched; the pillar marked with folds or plaits; operculum none.

Sub-fam. 1. VOLUTINÆ. *True Volutes.*

Spire shorter than the aperture, which is never striated; pillar with distinct plaits, the upper ones the shortest; tip of the spire papillary.* (*fig.* 81.)



Voluta *Linn.* Shell large, ventricose; the spire extremely short, very obtuse, and papillary; the terminal whorls, where they exist, being smooth and unsculptured.

1. *Turbinelliform* type. Shell melon-shaped; spire very

* Except in *Volutilithes*, which wants the three last characters, — the plaits being faint, the tip of the spire acute, and the lower plaits the longest.

short, sometimes nearly obsolete. (*fig.* 81. *b.*)
diadema. En. M. 388. f. 2.
armata. Ib. 388. f. 1.
tessellata. Mart. f. 781.
Æthiopica. En. M. 388. f. 3.
melo. Ib. 389. f. 1.
Neptuni. Ib. 386. f. 1.
Cymbium. Ib. f. 3.
proboscidalis. Ib. 389. f. 2.
Olla. Ib. 385. f. 2.
rubiginosa. Ex. Conch. 28.
porcina. En. M. 386. f. 2.

2. *Muriciform* type. Shell heavy, less ventricose, coronated with cylindrical or vaulted spines; spire more produced.
marmorata. Ex. Conch. pl. 1.
chrysostoma. Ib. pl. 45.
imperialis. En. Méth. 382. 1.

3. *Strombiform* type. Outer lip dilated, and angulated above.
scapha. En. Méth. 391. Exotic Conchology, pl. 48.

4. *Ancilliform* type. Aperture very wide; spire pointed.
angulata *Sw.* Ex. Conch. pl. 3, 4.

5. *Marginelliform* type. Shell partially polished; ventricose.
magnifica. Chem. 174, 175.
fulgetrum. *Sow.* Tank. C.

CYMBIOLA *Sw.* Spire more produced, but not more than half as long as the aperture; the terminal whorls regular and sculptured; plaits on the pillar four. (*fig.* 81. *a.*)

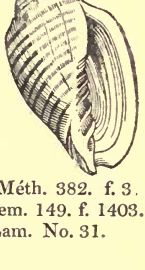
1. *Type?* Ancilla. En. Méth. 385. f. 3.
magellanica. Ib. f. 1.

2. Vespertilio. En. Méth. 378. f. 2.
nivosa. Ex. Conch. pl. 5.
pacifica. Chem. 178. f. 1713, 1714. Ex. Conch. pl. 14.
festiva. ? Lam. No. 42.

3. Mitis. Ex. Conch. pl. 40.

4. Braziliana. Chem. 176. f. 1695, 1696.

HARPULA *Sw.* Spire developed as in the last, but the tip is generally more slender, and the plaits are numerous.


82

1. Vexillum. En. Méth. 331. f. 1. (*fig.* 82.)
Lapponica. Ib. 381. f. 3.

2. Hebræa. En. Méth. 380. f. 2.
musica. Ib. 380. f. 1.
thiarella. Ib. 380. f. 2.
carneolata. Mart. 96. 930.
Guiniaca. Chem. 178. f. 1717, 1718.
lævigata. En. Méth. 379. f. 2.
polyzonalis. Ib. 379. f. 1.
fulva. En. Méth. 382. f. 3.
sulcata. Chem. 149. f. 1403.
nodulosa. Lam. No. 31.

3. fulminata. En. M. 381. f. 2.
4. bullata. Zool. Ill. ii. pl. 15. nucleus. Lam. No. 44.
5. Lyriformis. Zool. Ill. i. 54. concinna. Brod. Z. P. iv. 43. mitræformis. Lam. No. 43.

VOLUTILITHES *Sw.* Spire acutely pointed; plates generally faint, sometimes obsolete. (*fig.* 81. *e.*)

1. spinosa. En. M. 392. f. 6.
2. musicalis. En. M. 392. f. 4. muricina. Ib. 383. f. 1.
3. rarispina. En. M. 384. f. 2. labrella. Ib. 384. f. 3.
4. Cithara. En. M. 384. f. 1.
5. bicorona. En. M. 384. f. 6. crenulata. Ib. f. 5. costaria. Ib. 383. f. lyra. Ib. f. 6.

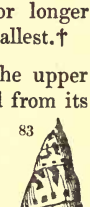
SCAPHELLA *Sw.* Shell smooth, almost polished; outer lip thickened internally; suture enamelled; lower plaits the smallest; apex of the spire various. (*fig.* 81. *c.*)

1. fusiformis *Sw.* Bligh, Cat. Junonia. Ex. Conch. pl. 33.
2. undulata. Ex. Conch. pl. 27. volvacia. Chem. f. 1339. Zebra *Sw.* (*fig.* 81. *c.*)
3. stromboïdes. (*fig.* 12. *a*, *b.* p. 123.)
5. papillosa *Sw.* Sow. Gen.

SUB-FAM. 2. MITRANÆ.

Spire produced, acute, generally as long* or longer than the aperture; plaits 4—5, the lower smallest.†

MITRA. No internal channel or groove at the upper extremity of the aperture; outer lip curved from its two extremities; the base of the aperture not contracted, the interior always smooth; spire lengthened, acute; shell without coronating tubercles, but not polished. Representing the *Volutæ* and *Turbinellidæ*.


83

Mitra Sw. Shell entirely smooth, or with the sutures very slightly crenated; aperture very effuse at the base. (*fig.* 83.)

episcopalis. En. M. 369. f. 2.
pertusa. Ib. 369. f. 1. 3.
versicolor. Martyn, 1. f. 23.
nivosa *Sw.* Bligh, Cat.
ambigua. Zool. Ill. ii. 30. f. 2.
fulva. Ib. f. 3.
Terebralis. En. M. 369. f. 5.
lactea. Ib. 371. f. 2.

* Except in *Conchelix.*

† Except in some *Mitreolæ.*

Thiarella Sw. Shell smooth, with the whorls coronated; the body-whorl less ventricose.

papalis. En. Méth. 370. 1.
pontificalis *Lam.* Ib. f. 2.
puncticulata. Lam. No. 4.
coronata. En. M. 371. f. 6.
millepora. En. M. 370. f. 5.
diadema *Sw.* Bligh, Cat. pl. 66.
lugubris. Zool. Ill. i.

Scabricola Sw. Shell rough, with transverse elevated ridges, and longitudinal striæ; suture not coronated; aperture effuse; outer lip crenated.

serpentina. En. M. 370. f. 3.
scabriuscula. Ib. 371. f. 5.
crenifera. Ib. 370. f. 4.
leucostoma *Sw.* Tank. Cat.
granatina. En. M. 371. f. 4.
filosa. Lam. No. 33.
granulosa. En. Méth. 370. f. 6.
texturata. Ib. 372. f. 2.
? terebralis. Lam. No. 11.

Nebularia Sw. Shell generally marked with transverse grooves; outer lip contracted above, effuse below; the margin smooth; base of the body-whorl narrowed.

contracta. Zool. Ill. i. pl. 18.
Ancillides. Zool. Proc. iii. 193.

Strigatella Sw. Size very small; spire thick, obtuse; outer lip thickened, and often reflected in the middle; aperture smooth.

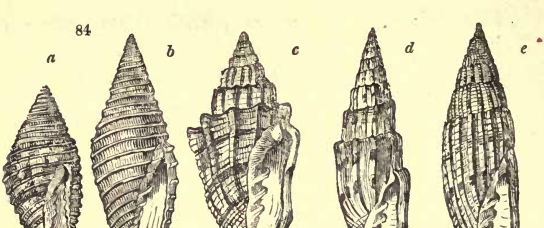
Zebra. En. M. 372. f. 8.
lineata *Sw.* Ib. 372. f. 7.
acuminata. Zool. Ill. ii. 128. f. 3.

Tiara *Sw.* Aperture narrow, linear, or of equal breadth throughout; outer lip and base of the body-whorl contracted, the former generally striated; an internal canal at the upper part of the aperture; shell (typically) turreted, and equally fusiform: representing the *Muricidæ* and *Cymbiola*. (*fig.* 84.)

Tiara Sw. Shell turreted, fusiform, costated, and semi-coronated; spire and aperture of equal length; internal striæ slight or obsolete. (*fig.* 84. *c.*)

virgo *Linn.* unfigured.*
Regina. Chem. 151. f. 1444.
vittata. Zool. Ill. i.
tæniata. En. M. 373. f. 7.
corrugata. Ib. f. 8. (*fig.* 84. *c.*)
costellaris. Ib. f. 3. (*fig.* 84. *g.*)
vulpicula. Ib. 373. f. 5.
nodosa *Sw.* Ib. 373. f. 2.
plicaria. En. M. 373. f. 6.
lyrata. Ib. 373. f. 1.
Caffra. Ib. 373. f. 4.
simplicata. Ib. 373. f. 9.
melongina. Ib. 373. f. 9.
foraminata. Zool. P. iii. 194.

* I have once seen this beautiful shell, the rarest and most slender of this genus.



Costellaria Sw. Unequally fusiform; the spire longer than the aperture; body-whorl slightly ventricose, but suddenly contracted near the base; internal striæ distinct; whorls convex, rarely angulated; the ribs reaching to the suture. (*fig.* 84. *d.*)

C. rigida. Zool. Ill. 1st Series, pl. 29.

Callithea Sw. Spire and aperture of nearly equal length; internal channel nearly obsolete; shell with *longitudinal* linear ribs, crossed with transverse striæ and bands; base contracted. (*fig.* 84. *e.*)

sanguisuga. En. Méth. 373. f. 10.

stigmataria. Chem. 151. f. 1442, 1443.

Cancilla Sw. General shape of the last; but the whorls crossed by *transverse* linear ribs, or elevated ridges; internal canal wanting; plaits very oblique; form slender; outer lip thin. (*fig.* 84. *b.*)

Isabella. Zool. Ill. ii. pl. 50.

sulcata. Ib. pl. 50. f. 2.

Pusia Sw. Size very small; spire thick, obtuse; outer lip thickened, and often reflected; aperture striated, with an internal canal.

microzonis. En. Méth. 374. f. 8.

Mitreola *Sw.* Small; unequally fusiform; the base obtuse; inner lip, typically, thickened, inflected, and either toothed or tuberculated; plaits on the pillar distinct, the inferior largest; tip of the spire some-

times papillary; aperture without either striæ or groove.

monodonta. Zool. Ill. ii. 128. f. 1. terebellum. Ib. f. 2.

CONŒLIX *Sw.* Small; cylindrical or conic; spire generally short and thick; plaits on the pillar numerous; exterior often decussated.

C. conulus. En. Méth. 382. f. 2.

MITRELLA *Sw.** Rather small; olive-shaped; unequally fusiform; always smooth and polished, and sometimes covered with an epidermis; base obtuse and effuse; spire nearly or quite equal to the aperture; plaits of the pillar few, oblique, and extending beyond the aperture, which is smooth internally. (M. bicolor, *fig.* 85.)

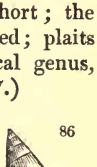
85

ocellata. Zl. Ill. v. pl. 54. f. 2.
fissurata. En. M. 371. f. 1.
casta. Zool. Ill. i. pl. 48.
bicolor. Ib. ii. 19. f. 2. (*fig.* 85.)
olivaria. En. M. 371. f. 2.
olivæformis. Zool. Ill. i. pl. 48. ii. 54. f. 3.
fusca. Ib. ii. pl. 54. f. 1.
dactylus. En. M. 372. f. 5.

SUB-FAM. 3. OLIVINÆ. *Olives.*

Shell smooth, highly polished; spire very short; the suture channeled; inner lip much thickened; plaits numerous, crowded, extending, in the typical genus, the whole length of the aperture. (*fig.* 86, 87.)

LAMPRODOMA *Sw.* Mitriform; spire produced, conic; resembling *Mitrella* in shape, but the suture is channelled; the aperture effuse at the base, contracted above; lower half of the pillar with 6–7 plaits.

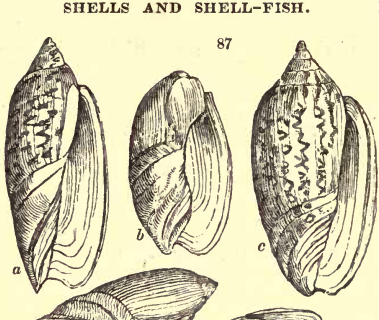

86

volutella. Zool. Ill. ii. series, pl. 40. f. 1. (*fig.* 86.)

OLIVA *Lam.* Cylindrical; spire very short, pointed; pillar with numerous slender plaits; aperture narrow; the base not effuse. (*fig.* 87. *c.*)

O. maura. Sow. Man. f. 457.

87



SCAPHULA *Sw.* (*fig.* 87. *b.*) Spire very short, thick, obtuse, and not defined; aperture very wide, with only two or three oblique plaits at the base.

S. patula *Sow.* Tank. Cat. 2331. (*b.*)

HIATULA *Sw.* (*fig.* 87. *a.*) General shape of *Oliva;* but the upper part of the pillar is not thickened; the lower tumid, and marked with a few oblique plaits; the aperture wide, the base effuse.

Lamarckii. Zl. Il. ii. p. 78. f. 1.
pallida. Ib. 78. f. 2.
maculosa. Ib. 78. f. 3.
? striata. Ib. pl. 40. f. 2.

OLIVELLA *Sw.** (*fig.* 87. *e.*) Oliviform; spire (typically) rather produced; the tip acute; inner lip not thickened; outer lip straight; base of the pillar curved inwards, and marked by two strong plaits; upper plaits obsolete or wanting; aperture effused at the base only.

biplicata. Tank. Cat. 2332.
purpurata. Zl. Ill. ii.. 58. f. 1.
mutabilis *Say.*
eburnea. Zool. Ill. ii. 58. f. 2.
conoidalis *Lam.* No. 57.
oryza *Lam.* No. 62.

SUB-FAM. 4. ANCILLARINÆ.

Shell oliviform, highly polished; aperture very effuse; suture concealed by enamel; base with one or two

* The union of the *Volutidæ* and the *Turbinellidæ* is so intimately effected by *Olivella biplicata* and *Pseudoliva plumbea* (see *fig.* 3. p. 82.), that the two plaits on the pillar of the former shell alone separate the two families.

strong grooves, which form a little tooth at the edge of the outer lip; inner lip wanting; base of the pillar thick, vitreous, obliquely striated, and turned outwards.

88

ANCILLARIA *Lam.* The characters, at present, are those of the sub-family, as the genera have not been worked out.

A. glabrata *Sw.* (*fig.* 88.)

SUB-FAM. 5. MARGINELLINÆ.

Shell small; oval; spire short or concealed; outer lip, and often the inner, very much thickened and inflexed, with the inner margin crenated; pillar with distinct plaits; the base with a wide, but not a deeply cleft notch.

89

VOLUTELLA *Sw.* Bulliform; ovate oblong; spire either entirely or almost concealed; pillar with four oblique plaits at the base; aperture not striated; outer lip smooth, thickened; inner lip wanting. (*fig.* 89.)

V. bullata Chemn. 150. f. 1409-10.
oblonga. Zool. Ill. ii. pl. 44. f. 1
guttata. Ib. f. 2.

PERSICOLA *Schum.* General form of *Volutella*; but the spire always concealed; plaitsnumerous, and extending nearly over the whole of the pillar; the aperture striated; inner lip thickened, spreading.

90

avellana. En. M. 377. f. 5.
maculata *Sw.* Ib. f. 3.
lineata. En. M. 377. f. 4. (*fig.* 90.)

GIBBERULA *Sw.* Sub-oval; spire slightly prominent; top of the outer lip dilated and gibbous; base of the inner lip with plaits; inner lip broad, spreading.

G. zonata. En. Méth. 374. f. 6.

MARGINELLA *Lam.* Oval; spire slightly prominent;

inner lip very much developed, and forming a tumid rim all round the aperture.

M. lactea *Sw.* Sow. Gen. f. 3.

91

GLABELLA *Sw.* Volutiform; the spire more or less conic, and well developed; pillar with basal plaits; inner lip obsolete; outer lip thick, toothed, or crenated; rarely smooth.* (*fig.* 91.)

P. ruffina *Sw.* En. Méth. 377. f. 6.
Goodalli. Tan. Cat. 2151 *a.*
Faba. En. Méth. 377. f. 1.
nubicola. En. M. 377. f. 2.
bifasciata. Ib. f. 8.
limbata. Ib. 376. f. 3.
cærulescens. Ib. 376. f. 8.

FAMILY 5. CYPRÆIDÆ. *Cowries.*

Oval; polished; spire entirely concealed; aperture as long as the shell, narrow, and open at each end; outer lip generally thickened and inflected.

SUB-FAM. 1. CYPRÆINÆ.

Inner lip striated or toothed.

92

CYPRÆA *Linn.* Shell always entirely smooth; the extremities of the aperture obtuse; the teeth marginal, and not extending over the circumference of the lips.

C. Arabica. Sow. Man. f. 445, 446.
caput-serpentis *Lam.* (*fig.* 92.)

PUSTULARIA *Sw.* Shell generally marked by elevated pustules; aperture very narrow, and linear; the extremities more or less produced; the teeth continued beyond, and frequently forming elevated striæ across the lips.

P. cicercula. En. Méth. 355. f. 1.
globulus. (Aberrant.) En. Méth. 356. f. 2.

* *M. cærulescens* Lam. (*prunum* Linn.) unites this type to *Volutella.*

TRIVEA *Gray.* Shell marked with transverse, uninterrupted, elevated lines, uniting with the teeth; the aperture wide, and the extremities obtuse; inner lip with a thickened protuberance; pillar concave within.

coccinella. En. M. 356. f. 1. Pediculus *Auct.*

CYPRÆDIA *Sw.* Cypræform; the base contracted; the body-whorl not flattened beneath; shell cancellated; aperture of equal breadth throughout; a few thickened, short teeth on the pillar; lip at the base, which is not internally concave.*

C. cancellata *Sw.* Sp. Nov.

CYPRÆOVA† *Gray.* Cypræform; teeth of the inner lip wanting, being represented by fine raised lines continued on the back of the shell; aperture rather effuse; top of the outer lip much projecting.

C. capensis. Sow. Man. f. 444. algoensis *Gray.* (Aberrant.) Sow. Man. f. 447.

SUB-FAM. 2. OVULINÆ

Oviform; smooth, polished; the extremities of the aperture more or less produced; inner lip without teeth.

CYPRÆLLA *Sw.* Cypræform; inner lip thickened above into a point as long as the outer lip, the marginal teeth of which are very regular; a circular depressed line at each extremity.

C. verrucosa. En. Méth. 357. f. 5.

OVULA *Lam.* Oviform; top of the outer lip elevated and produced beyond that of the inner, which is turned and much thickened; both lips equal at their base, and slightly produced.

O. ovum. En. Méth. 358. f. 1.

BIROSTRA *Sw.* The two ends of the aperture suddenly

*-Fossil only; differing from *Trivea* in its contracted base, in the equality of its aperture, and the equal convexity of the inner lip within.
† Abbreviated from *Cypræovulum.* This seems the strombiform type.

contracted and produced into two long beak-like processes; aperture effuse; the outer lip inflected, but not toothed.

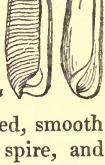
B. volva. En. Méth. 357. f. 3.

Carinea *Sw.* Oblong; the extremities not produced; aperture nearly straight, almost central, contracted above, and very effuse below; lips equal; the outer slightly toothed.

C. gibbosa. En. Méth. 357. f. 4. (*fig.* 93.)

Volvaria *Lam.* Cylindrical; lengthened; the extremities obtuse; the surface sculptured; base of the pillar with 3—5 distinct plaits; outer lip crenated; aperture linear; fossil.

V. concinna. Sow. Man. f. 439. (*fig.* 94. *a.*)



Cylindrella *Sw.* Cylindrical, narrow, and obtuse, as in *Volvaria;* but the surface and outer lip are smooth, and there are no plaits on the pillar.

C. alba *Sw.* (*fig.* 94. *b.*)

Erato *Risso.* Ovate, more or less angulated, smooth or granulated, with a dorsal scar, short spire, and large, angulated, emarginated aperture; pillar slightly crenated; outer lip reflected, and denticulated on the inner edge; sutures covered with enamel.*

E. Maugeri. Sow. Man. 43. f. 454.

Order PHYTOPHAGA.

Family 1. HELICIDÆ. *Snails.*

Animal pulmonary; breathing by a lateral opening; shell light, turbinated, or spiral; the aperture always

* I have not seen this curious little genus. Mr. Sowerby, in addition to the above, adds, "it resembles *Marginella*, but has no folds on the pillar. Having a groove down the back, he considers it intermediate between *Marginella* and *Cypræa*," (or rather *Trivea*). The circle of the *Cypræidæ* is thus closed, and its union with the *Volutidæ* at once established.

entire, rarely closed by an operculum, and sometimes only rudimentary.

Subfam. 1. LIMACINÆ. *Slugs.*

Shell very thin, often rudimentary, and generally too small to contain the entire animal; tentacula, when present, cylindrical, and bearing the eyes at their tip.

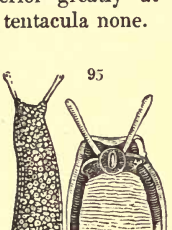
Herpa. Tentacula two, or none; shell none; jaws none, or not discernible.

Herpa Guild. Linear, fusiform, anterior greatly attenuated; eyes very small, sessile; tentacula none.

H. gigas. See App.

Onchidium Buch. (*fig.* 95.) Tentacula two; mantle very large, tuberculated, almost covering the body; mouth with two triangular flattened lobes.

Typhœ *Buch.* Lin. Tr. v. 132.


95

Limax *Linn.* Tentacula four; shell rudimentary, or none.

Limax Linn. Orifice near the posterior part of the mantle; shell very small.

L. variegatus. Griff. Cuv. pl. 35. f. 2.

Arion Fér. Orifice near the anterior end of the mantle; shell none.

A. empiricorum. Griff. Cuv. pl. 35. f. 1.

Vaginula Fér. Mantle large, covering the whole body; no shell.

V. Taunaysii. Griff. Cuv. pl. 35. f. 7.

Parmacella Lam. Mantle moderate, membranaceous, placed on the middle of the back; the edges loose; shell oblong, flat; spire minute.

P Olivieri. Griff. Cuv. pl. 35. f. 5.

Testacella Lam. Mantle very small, and placed at the posterior extremity of the body; shell small.

T. haliotoïdea. Griff. Cuv. pl. 35. f. 4.

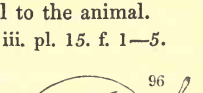
VITRINA *Drap.** Mantle with a double border; the upper one lobed, and folded back upon the shell; posterior part of the body obtuse, truncate; shell slightly turbinate, thin, ear-shaped, polished; too small, in general, to contain the animal.

V. pellucida. Drap. Moll.

STENOPUS *Guilding.* Body linear, long; the disk very narrow, superior; tentacula thickened, clavate; shell thin, nearly discoid, nearly equal to the animal.

S. cruentatus *Guild.* Zool. Journ. iii. pl. 15. f. 1—5.

SUCCINEA *Drap.*† Shell nearly equal to the animal; oblong, thin; spire short, pillar none; aperture very large.


96

S. amphibia. Sow. Man. f. 265. (*fig.* 96.)

SUB-FAM. 2. LUCERNINÆ. *Land Volutes, or Lamp Snails.*

Shell discoid; the spire scarcely raised; the substance solid; surface either granulated or striated; aperture generally toothed.

LEIOSTOMA *Sw.* Shell patulous; the aperture very large and wide; spire of only two or three small whorls; outer lip reflected.

Leiostoma Sw. Surface granulated; a transparent glazing extending far beyond the inner lip.

gigantea. Fer. 15. f. 5, 6, 7.
Jamaicensis. Ib. 14. f. 6—8.
vesicalis. Chem. 208. f. 2051, 2052.

LUCERNA *Humph.* Shell discoid, of several graduated whorls; the surface granulated; the spire slightly elevated; circumference carinated; teeth, when present, on the outer lip only.

Caracolla Lam. Aperture circular; the two lips united; teeth none; umbilicus open.

lapicida. Chem. f. 1107.
tectiformis. Zool. J. i. pl. 3. f. 6.

* The sub-genera remain to be determined.
† The same remark.

Discodoma Sw. Teeth none; aperture angulated; the inner lip nearly obsolete, the outer only slightly thickened; margin carinated.

albilabris. Chem. 125, f. 1090, 1091.
Gualteriana. Chem. 5. vig. 44. *a—c.*
inflata. Ib. 126. f. 1100, 1.
marginata. Ib. 102. f. 1095.
gigas. Ib. f. 2044, 5.
angistoma. Ib. 125. f. 1092.

Lucerna Humph. Outer lip with teeth, either marginal or internal; the outer lip thick and reflected; circumference carinated.

acutissima. Zool. Ill. ii. pl. 96.*
fasciata *Guild.* Bow. Conch. 7. f. 23.
lanx. En. Méth. 462. f. 2.
fulgurata *Sow.*†
lychnuchus. Ch. 126. f. 1108.
sinuata. Chem. 126. f. 1110—1102. (Aberrant.)

Anastoma Lam. Aperture turned upwards, furnished with plaited teeth on both sides.

A. depressa. Chem. 109. f. 919, 920.

Lucidula Sw. Aperture transverse; both lips much thickened and united; the outer with marginal obsolete teeth at the base; umbilicus closed.

‡ Barbadensis *Lam.* No. 49. p. 78. Fér. Moll. pl. 47. 2, 3, 4.

Lucernella *Sw.* Teeth on both sides of the aperture; surface regularly and distinctly striated. Circumference convex.‡

Polydontes Montf. Aperture nearly circular, surrounded with obtuse tubercular teeth.

P. imperator. Bowdich, Elem. of Conch. pl. 7. f. 21.

Lyrostoma Sw. Aperture lyre-shaped, very contracted near the body-whorl, widened beyond.

L. labyrintha. Chem. pl. 208. f. 2048. Lam. p. 46.

* The original figure of the shell and animal given in Zool. Ill. is copied by Férussac, Guérin, and numerous others, but so badly, that the shell appears to be a totally different species.

† Mr. Sowerby has published a very beautiful detached plate of this species, first described by himself.

‡ Some slight variation has been made in the arrangement of this group from that previously stated at p. 193. *Cyclodoma* is here united to *Lucernella*, and the new sub-genus *Lyriostoma* proposed.

Lucernella Sw. Shell small, striated; outer lip with marginal, not internal, teeth; inner lip with an elevated toothlike plate; umbilicus generally pervious.

L. hippocastaneum. Chem. 209. f. 2055, 2056.

*Polygyra.** Shell completely discoid; no pillar; aperture angulated and margined; a small tooth on the inner lip.

P. septemvolvus. Sow. Man. f. 275, 276. carabinata. Bow. Conch. pl. 7. f. 19.

Lucidella Sw. Sub-trochiform; spire conic, and suddenly pointed; outer lip with marginal tuberculated teeth.†

L. aureola. Zool. Journ. i. pl. 6. f. 15.

Pusiodon *Sw.* Shell flattened, smooth; the body-whorl large, and much dilated at the aperture; spire small, flat, of three or four contracted whorls; aperture very oblique, sinuated, or obsoletely toothed at the base of the outer lip, which is spreading and sub-reflected; inner lip obsolete; umbilicus open.

zonaria. Chem. 132.f. 1188. auriculata. Zool. Ill. i. pl. 6.

Thelidomus *Sw.* Shell coarsely granulated; body-whorl and spire as in the last genus; but the former is more ventricose, and the latter more raised, and somewhat distorted; outer lip thickened and reflected; the base broad and flattened, sometimes with granulated marginal teeth; umbilicus none.

T. (Helix) striolata *Guild.* also Fér. Moll. 44. f. 1-4.

Sub-fam. 3. HELICINÆ. *Common Land Snails.*

Shell ventricose, turbinated; the aperture transversely oval, never toothed; the body-whorl large and ventricose.‡

Helix. *Linn.* Shell globose, turbinate; body-whorl ventricose; spire slightly raised, obtuse.

* I find this name as above quoted, but no mention is made in the text of whose genus it is.

† I have been obliged to designate what seem to be the types of this genus, in order to show more clearly its union, on one side with Cyclostoma, and on the other with Clausilia, or the toothed division of the Achatinæ. Mr. Gray's valuable paper may be consulted with much advantage

‡ Except in *Pupa*, which has teeth, and a small body-whorl.

Hemicycla Sw. Shell discoid; spire rather flattened, but not small, and of four whorls; outer lip semicircular, dilated into a broad, flat margin, but not reflected; inner lip nearly obsolete, but sometimes with a small obsolete tooth; umbilicus none; surface distinctly striated.

H. plicaria. En. Méth. 462. f. 3.

Helix Auct. Body-whorl ventricose; spire more or less conic, but always shorter than the aperture; umbilicus almost always closed, or not existing; outer lip reflected or thickened.

pomatia. Chem. 128. f. 1138.
aspera. Penn. pl. 87. f. 3.
lactea. Chem. 120. f. 1161.
hœmastoma. Ch. 130. f. 1150.
melanotragus. En. Méth. 462. f. 4.

Zonites Montf. Shell sub-ventricose, but the body-whorl depressed, the margins convex; spire often of many whorls; outer lip thin; umbilicus open.

unizonalis. En. M. 462. f. 6.
citrina. Chem. 131. f. 1177.

Epistyla Sw. Shell very thick, conic, and obtuse; the whorls very numerous; body-whorl and aperture small; outer lip thin.

E. conica *Sw.* Sow. Man. f. 281.

Streptaxis Gray. Heliciform; but the pillar or axis not perpendicular, which gives the body-whorl a distorted appearance; umbilicus small, open; spire of six whorls; outer lip thickened.

S. contusa *Gray.* Sow. Man. f. 269, 270.

GEOTROCHUS *Sw.* Shell somewhat spiral; the spire being conical, often trochiform, and always longer than the aperture, which is transverse and without teeth.

Hemitrochus Sw. Whorls convex; spire conic, obtuse, not longer than the aperture; outer lip having a thickened rim inside the margin, which is acute; umbilicus closed.

H. hœmastomus *Sw.* (See *fig.* 19. p. 165.)

Geotrochus Sw. Trochiform; the body-whorl more or less carinated; the spire pointed and acute; outer lip thickened and reflected, inner almost obsolete; umbilicus almost obsolete.

pileus Zool. Ill. ii. pl. 91. Ferussacii Lesson, Voy. 8. f. 5.

Pythohelix Sw. Sub-spiral; body-whorl large, ventricose, and hardly angulated; spire convex and obtuse; outer lip thickened and reflected, generally separated from the pillar by a sinus; umbilicus none; aperture nearly round.

P. castanea *Sw.* Bow. Conch. pl. 8. f. 27.

Geomitra Sw. Conic, thick, obtuse; the whorls striated, and coronated with tubercles; body-whorl small; aperture very small, circular; lips united, the outer one thin; umbilicus small.

bicarinata. Zool. Journ. i. pl. 3. f. 7. (*fig.* 20. p. 166.)

Gonidomus Sw. Conic, thick, obtuse; the spiral whorls distorted; body-whorl contracted; aperture oval, perpendicular; the lips thickened; umbilicus open, but not deep.*

? pagodus. Lesson, Voy. pl. 8. f. 6. (*fig.* 21. p. 166.)

Pupa. Shell cylindrical; the spire much produced; the middle whorls thicker than the body-whorl; teeth generally on the pillar, but none on the outer lip; aperture mostly round.

Plicadomus Sw. Spire moderate, regular, and thick, but gradually conic; the tip obtuse; aperture perpendicular; inner lip wanting; outer lip semicircular; the margin dilated and reflected.

P. sulcata. Chem. 135. f. 1231, 1232.

Pupa Lam. Spire thickest towards the middle; the tip abruptly pointed; aperture oval; the lips considerably thickened and united; a single plait generally on the pillar.

P. mumia. Mart. 153. f. 1439.

* This seems to represent *Streptaxis*.

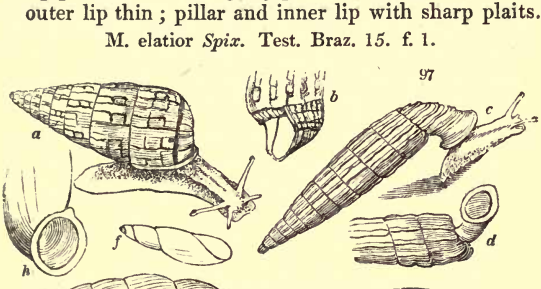
Gonospira Sw. Spire perfectly cylindrical, of equal thickness, the tip obtuse, with the whorls large ; aperture oval ; lips thickened ; pillar with or without a plait.

G. polanga *Desh.* Lesson, Voy. pl. 8. f. 8.

Megaspira Lea. Spire excessively long, of more than twenty volutions, and of nearly equal thickness ; the tip persistent, and slightly pointed ; aperture rounded ; outer lip thin ; pillar and inner lip with sharp plaits.

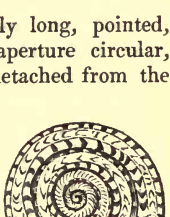
M. elatior *Spix.* Test. Braz. 15. f. 1.

97



Siphonostoma Guild. Spire excessively long, pointed, but the upper portion deciduous ; aperture circular, spreading ; the lips united, and detached from the adjoining whorl. (*fig.* 97. *c*, *d.*)

S. costata *Guild.* (*fig.* 97. *c*, *d.*) fasciata. En. Méth. 461. f. 7.



98

HELICELLA *Féruss.* Shell discoid, but the body-whorl thick and ventricose ; the spire very small and sunk ; pillar none ; aperture semicircular ; outer lip thickened ; umbilicus very wide. (*fig.* 98.)

pellis-serpentis (*fig.* 98.) ; also Fér. Mollus. pl. 66. 73. 75. 77.

Sub-fam. 4. ACHATINÆ.

Shell spiral; aperture oblong or oval, always equal, and generally shorter than the spire.*

Clausilia *Drap.* Aperture oblong, with teeth on both sides †; shell cylindrical.

Pupella Sw. ‡ Spire moderate, obtuse; the whorls of equal thickness; basal whorl and aperture small; the latter with teeth on both sides; the lips not thickened.

frumentum. Drap. 3. f. 51, 52. vertigo. Bow. Conch. 8. f. 35.
variabilis. Ib. f. 55, 56.

Eruca Sw. General habit of the last; but the tip of the spire is thicker, and there is only one, or no plate, upon the inner lip only.

muscorum. Drap. 3. f. 36–38. dolium. Drap. 3. f. 43.
fragilis. Ib. 4. f. 4. umbilicata. Ib. 3. f. 39, 40.

Balia Gray. Spire very long, of numerous persistent whorls; aperture simple, without teeth or folds.

B. fragilis. Drap. pl. iv. f. 4. ventricosa. Zool. Journ. i. pl. 5, 6.

Clausilia Drap. Spire very long, but the upper portion deciduous; aperture oblong, ear-shaped, with teeth on both sides; the lips united, and their edges spreading.

papillaris. Drap. 4. f. 13. plicatula. Ib. 4. f. 17, 18.

Macrodontes Sw. Size larger; bulimiform; spire longer than the aperture, which is surrounded with large teeth; lips united; the outer large, dilated, and the edge reflected. Tropical America only.

M. Sowerbeyii *Sw.* Zool. Journ. i. pl. 5. f. 2.

2. Bulimus. Basal whorl ventricose; outer lip mar-

* Except in *Helicina* and the turbinated *Cyclostomæ*.
† Except in *Balia*, which has no teeth.
‡ Including the European *Pupæ*, *Vertigo*, and *Alæ*.

gined and reflected; aperture without teeth, rarely with a single fold.*

Auricula Lam. Body-whorl sub-ventricose; spire short; the whorls few; pillar with one or two plaits; outer lip margined and reflected.

Sileni. En. Méth. 460. f. 4. leporis. *Lam.* (*fig.* 27. p. 181.)

Bulimus Lam. Outer lip thickened and reflected; spire short; pillar smooth.

melanostomus. Zool. Ill. i. 4. Australis. Bow. C. 8. f. 30.

Bulimulus Leach. Outer lip thin, or sub-reflected; spire equal or rarely longer than the aperture.

undulatus *Guild.* Zool. J. iv. 169. Antiguensis. Ib.
stramineus. Ib. iv. 170. Proteus. Ib.

Leptospira Sw. Spire excessively long, sub-cylindrical; body-whorl largest; outer lip thickened; aperture oval; no teeth.

striata *Sw.* Chém. 135. f. 1226. signata *Sw.* (*fig.* 97. *a*, *b*.)

Goniostoma Sw. Spire elongated, of few whorls; aperture contracted at each end; lips margined; the pillar curving inwards; the base slightly notched.

T. erubescens *Sw.* Zool. Journ. i. pl. 5. f. 2.†

3. ACHATINA. Outer lip always thin; base of the pillar truncated, or sinuated, before it joins the outer lip.

Macrospira Guild.‡ Spire excessively long, sub-cylindrical; body-whorl largest; outer lip thin; aperture oval.

M. octona. (*Helix octona* Auct.) aperta *Guild.* (*fig.* 97. *e*, *f*.)

Cochlycopa§ Fér. Oblong; body-whorl slender; surface striated; spire variable; outer lip with a prominent lobe near the base.

C. glans. Chem. 117. f. 1009, 1010.

* Only in *Auricula*.
† The singular lateral position of the aperture is not expressed in this figure. See *fig.* 25. p. 177.
‡ Subsequently named, inadvertently, *Chionella*, by Mr. Jeffreys.
§ Very properly substituted by Férussac for *Polyphemus*.

Achatina Lam. Oblong; body-whorl ventricose; surface smooth; spire variable; outer lip without any lobe. (*fig.* 23. p. 170.)

A. marginata *Sw.* Zool. Ill. 1st Series, pl. 30.

Achatinella Sw. Small; sub-trochiform; spire obtuse; outer lip with a thickened internal margin.

A. pica. Zool. Ill. ii. Series, pl. 99.

Leucostoma *Sw.* General shape of the last, but the upper lip has a thick pad at the top, and another over the base; affinities doubtful.

L. variegata *Sw.* (*fig.* 24. p. 172.)

Cyclostoma. Aperture circular, and closed by an operculum; the margins of both lips united.

Cyclophora Montf. Turbinate; the spire very short, and generally pointed; umbilicus very large; aperture entire.

unicarinata. En. M. 461. f. 1.
volvula. Ib. f. 5.
lincina. Ib. f. 2.
pulchra. Sow. Gen. f. 2.
ligatum. Ib. f. 4.
involvula. Sow. Man. f. 304.
articulata. Griff. Cuv. 28. f. 1.
pulchra. Ib. f. 3.
Madagascariensis. Ib. f. 4.
auricularis. Ib. f. 5.

Cyclostoma Drap. Spiral; spire sub-cylindrical and obtuse; pillar sometimes wanting; umbilicus small, or closed.

C. labio. En. Méth. 461. f. 4.

Cyclotus Guild. Nearly discoid; pillar none; spire scarcely raised, and the tip obtuse; a small siphon at the top part of the aperture.

planorbulus. En. M. 461. f. 3. variegatus *Sw.* Sow. Gen. f. 1.

Megalomastoma Guild. Cylindrical, resembling *Pupa*, but has a horny operculum; spire not thickened; teeth or fold on the pillar none. (*fig.* 97. *g, h, i.*)

flavula *Sw.* En. Méth. 461. f. 6. brunnea *Guild.* (*fig.* 93. *g, h, i.*)

Helicina *Lam.* Shell turbinate; outer lip thickened, and reflected; inner lip thick, and spreading over the umbilicus; aperture semicircular, or lunate.

Helicina Lam. Heliciform; aperture with an open slit, or narrow fissure at the base.

major *Gray.* Zool. Journ. i. sub-marginata. Ib. pl. 6. f. 11. 68. pl. 6. f. 10.

Pachytoma Sw. Aperture entire; the inner lip very thick; the spiral whorls hardly convex.

occidentalis. Zool. J. iii. 15. viridis. Zool. Journ. i. pl. 6. f. 6—10. (*fig.* 28. p. 184.) f. 7.

Oligyra Say. Aperture entire; the base of the pillar produced beyond.

rhodostoma. Zool. Journ. i. pl. 6. f. 9. orbiculata *Say.*

Trochatella Sw. Trochiform; spire elevated, acute; inner lip very thin; outer lip spreading: representing *Cyclophora.*

T. pulchella. Zool. Journ. i. pl. 6. f. 1.

SUB-FAM. 5. LIMNACINÆ. *River Snails.*

Animal pulmoniferous; tentacula two, often flat; the eyes basal (*fig.* 100. *e*); shell very thin; operculum none.

PLANORBIS. Shell discoid, both surfaces nearly alike; pillar none; aperture oblique; aperture reversed.

Planorbis Drap. Spiral whorls few; body-whorl ventricose.

P. corneus. Drap. 1. f. 42—44. Sow. Man. f. 311.

Spirorbis Sw. Shell greatly depressed; the whorls very numerous.

S. vulgaris. Drap. 2. f. 6, 7.

Helisoma Sw. Shell ventricose, the spire sunk below the body-whorl; whorls hardly three.

H. bicarinata. Sow. Gen. f. 4.

Segmentaria Flem.* Shell greatly depressed; the whorls very few; the internal cavity divided, by

* It is not a little extraordinary, that no writer, that I am aware of, British or Continental, has adopted this, the most remarkable type among the aquatic *Pulmonaria.* Dr. Fleming deserves much credit for being the first who characterised it.

transverse testaceous partitions, into chambers, which communicate with each other by triradiated apertures. Representing the *Cephalopoda*.

S. lacustris *Flem.*

LIMNEA *Lam.* Very thin spiral; the spire variable in length, but always pointed; aperture large, effuse; outer lip, typically, much dilated and rounded.

99

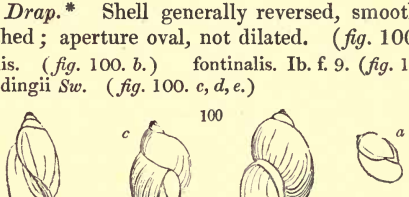
L. stagnalis. Sow. Man. f. 308. (*fig.* 99.)
aserta. Ib. f. 309.

Leptolimnea Sw. Nearly cylindical; spire thick, lengthened, longer than the aperture; which latter is small.

L. elongata. Sow. Gen. f. 6.

PHYSA *Drap.** Shell generally reversed, smooth, and polished; aperture oval, not dilated. (*fig.* 100.)

rivalis. (*fig.* 100. *b.*) fontinalis. Ib. f. 9. (*fig.* 100. *a.*)
Guildingii *Sw.* (*fig.* 100. *c, d, e.*)



POTOMOPHILA *Sw.* Shell resembling a *Limnea*, but with a distinct fold on the pillar.

P. bulimoïdes. En. Méth. 459. f. 7. (*fig.* 31. p. 187.)

ANCYLUS *Lam.* Shell thin, patelliform; resembling a limpet.

A. fluviatilis. Sow. Man. f. 246.

FAMILY TURBIDÆ.

Shell solid, but not perlaceous, spiral; aperture entire, closed by an operculum.

* Between the shells of *Physa* and *Lymnea* there is no great difference; but their animals are too distinct to be united in any system of malacology.

Ampullacera

SUB-FAM.? THALLICERA.

THALLICERA *Quoy.* Shell globose; spire depressed; outer lip thin, with a sinus above; inner lip thickened, with a prominent plait near the base.

T. avellana. (*fig.* 34. p. 196.) Chem. 188. f. 1919–20.

SUB-FAM. AMPULLARINÆ.

Animal with a respiratory siphon; shell globular or turbinate.

VALVATA *Drap** Shell turbinate, sometimes nearly discoid; spire very short; the whorls convex; aperture circular; operculum spiral; umbilicus pervious.

V. piscinalis. Sow. Man. f. 322.

AMPULLARIA *Lam.* Shell globose, rarely discoid, turbinate; spire very short; aperture oblong, pointed above, rounded below.

Ampullaria Lam. Outer lip thin; operculum horny.

fasciata *Lam.* (*fig.* 101. *a.*)

Pachylabra.† Outer lip thickened; operculum shelly.

globosa *Sw.* Zool. Ill. i. pl. 119.

Lanites Montf. Shell reversed; the body-whorl ventricose only in the middle; outer lip generally thin.

L. Guinaica. Sow. Man. f. 319.

Ceratodes Guild. Shell discoid; body-whorl higher than the spiral whorls; outer lip thin; operculum horny.

C. Cornu-Arietis. Sow. Man. f. 320.

PALUDINA. Spiral; spire equal, or longer than the aperture; lips thin.

* Affinities uncertain.

† *Pachystoma* Guild., already used in Ichthyology.

Paludina Lam. Whorls inflated; umbilicus open; operculum horny; aperture ovately round.

elongata. Zool. Ill. i. pl. 98. (*fig.* 101. *b.*) unicolor. Ib. (*c.*)

Nematura Benson.* Whorls slightly convex; aperture small, oblique, contracted; operculum spiral, horny.

Sow. Man. f. 305.

Meladomus *Sw.* Spire pointed; aperture oval, reversed, pointed, and contracted above; umbilicus none; operculum ——?

M. bulimoïdes.† Sw. Sp. Nov.

Sub-fam. MELANIANÆ.

Shell spiral; the spire always as long as, and generally much longer than, the aperture; body-whorl small.‡

Paludomus *Sw.* Shell oblong-globose, strong; spire shorter than the aperture; inner lip very thick.

Paludomus. Shell smooth; outer lip slightly spreading, the margin crenated; inner lip very thick and enameled. India.

P. globulosa. Griff. Cuv. xii. pl. 14. f. 6. conica. Griff. Cuv. f. 5. retusa. Ib. f. 9.

Anculosa Say. Spire very short; outer lip sinuated, thin; top of the inner lip thickened internally; but obsolete in the middle, and flat at the base. America.

prærosa and monodontoides *Say.* Sow. Man. 314.

Hemimitra Sw. Resembling *Paludomus*; but the whorls are coronated. India.

H. retusa. Sw. Sp. Nov.

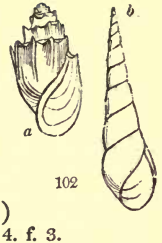
Melania. Shell elongated, spiral; the aperture oval, entire; the outer lip dilated at its base.

* I do not know this type.

† Entirely brownish black. The shape and size similar to *Bulimus citrinus*; but the outer lip thin. Inhabits China?

‡ Except in *Paludomus*, which blends into *Meladomus*, and thus unites this with the last sub-family.

Melacantha Sw. Spire and aperture nearly of equal length; the whorls coronated with spines; inner lip very thin.



102

M. amarula *Sw.* Zool. Ill. ii. pl. 29. f. 1. (*fig.* 102. *a.*)
setosa *Sw.* Ib. ii. f. 2.

Melania Lam. Subulate and elongated; inner lip wanting. (*fig.* 102. *b.*)

M. quadriseriata. Griff. Cuv. 14. f. 3.

Potadoma Sw.* General characters of *Melania;* but the outer lip is hardly dilated, and the top of the inner lip is internally thickened.

P. Frethii. Griff. Cuv. 14. f. 2. lævis. Ib. 14 f. 8.

Hemisinus Sw. General shape of *Melania;* but the base of the aperture is contracted and emarginate; outer lip crenated.

H. lineolata. Griff. Cuv. xii. pl. 13. f. 4.

Melanella Sw Obovate; spire scarcely longer than the aperture, which is entire; inner lip much thickened its whole extent.†

MELANOPSIS *Lam.* General form of *Melania;* but the spire shorter, and the base of the aperture notched.

Melafusus Sw. Sub-fusiform; the base contracted, and the aperture and spire nearly equal.

1 Species, America.

Melanopsis Lam. Obovate; the base obtuse; spire pointed, acute; inner lip greatly thickened, particularly at its upper part, and internally; suture compressed and flattened.

103

buccinoides *Lam.* (*fig.* 103.)

Melanithes Sw. Habit of *Melania;* but the spire is obtuse, and the suture prominent.

Férus. Moll. Melanop. pl. 2. f. 11, 12, 13., pl. 1. f. 5. 7. 16.

* I suspect that the true distinction of this second type of *Melania* will rest on the deciduous nature of the spire.

† This type, which represents *Planaxis,* unites on the other side to *Melacantha.* I have a small species, but know not whether it is described.

Canthidomus Sw. Spire generally short; whorls coronated with spines, or marked with longitudinal ribs; base obtuse.

Férus. Moll. Melanop. pl. 2. costata. Sow. Gen. f. 3. f. 9. 10., pl. 1. 13, 14, 15.

Melatoma Sw. Fusiform; longitudinally ribbed; a deep sinus at the top of the outer lip; base contracted, channel wide.*

M. costata *Sw.* (*fig.* 104.)

104

Cerithidea. Clavate; cerithiform; aperture sub-emarginate.

Triphorus Desh. Shell small, slender, subcylindrical; spire long, of numerous whorls; aperture sinistral; outer lip reflected over and united to the inner, but leaving a circular opening.

T. costata. Sow. Gen. f. 375.

Cerithidea Sw. Shell light; decollated; outer lip semicircular, dilated by a flattened border; aperture emarginate.

C. lineolata. Griff. Cuv. 14. f. 4. fragilis. Ib. 32. f. 12.

Ceriphasia Sw. Cerithiform; outer lip thin, dilated at the base; aperture small, slightly emarginate, without any internal groove; inner lip thin.

C. sulcata *Sw.* (*fig.* 38. p. 204.)

Planaxis. Animal marine; shell obovate; inner lip much thickened above; pillar flattened; the base with a small notch or sinus.

P. semisulcatus *Lam.* Sow. Gen. f. 3.

Sub-fam. TURBINÆ.

Animal marine; shell solid, spiral; aperture round or oval, entire, sometimes toothed.†

* Representing *Pleurotoma*, and united to *Melafusus*.

† Except certain types of *Melampus*, which appear amphibious; and others which have plaits and teeth on the aperture.

SCALARIA *Lam.* Shell turreted, marked with longitudinal ribs; aperture circular, entire.

pretiosa. En. Méth. 481. f. 1.

TURRITELLA. Shell turreted; spire subulate, very long; umbilicus none.

Rissoa Fremonville. Spire moderate, perpendicular, acute; outer lip thickened; aperture oval.

R. reticulata. Sow. Man. 346.

Turritella Lam. Aperture round, entire; outer lip thin.

T. duplicata. En. Méth. 449. f. 1.

Eulima Desh. Shell smooth, polished; spire distorted, acute; outer lip thin, dilated in the middle.

E. labiosa. Sow. Man. f. 347. marmorata. Ib. f. 348.

Pyramidella Lam. Shell smooth, polished; outer lip thin; base of the pillar produced, and marked with distinct plaits.

P. terebellum. Sow. Man. f. 342.

Truncatella Risso. Cylindrical; turreted; the apex very obtuse; aperture oval, small, entire; the lips united.

T. lævigata *Risso.* Drap. pl. 1. f. 31. costulata. Zool. Ill. pl. 13. f. 13—18.

TURBO *Linn.** Shell turbinate; spire short, generally pointed, not longer than the aperture; inner lip flattened, broad.

littoreus (the common winkle). Sow. Man. 363. (*fig.* 109. *e.*)

Tornatella† Lam. Animal marine; shell solid; body-whorl cylindrical; spire pyramidical, pointed; aperture contracted above; effuse beneath; base of the pillar with two strong plaits; outer lip very thin.

T. fasciata. En. Méth. 452. f. 3.

MELAMPUS. *Amphibious Volutes.* Obovate, or oval; the spire generally short, and never longer than the

* *Tuba*, *Assiminea*, and *Monatigma*, which may probably be sub-genera, I am not acquainted with; and, as their animals appear unknown, I am fearful of locating them incorrectly.

† This sub-genus possibly unites TURBO to *Melampus*; it is the only one which has that sort of colouring peculiar to marine shells.

aperture; outer lip thin, but thickened on the internal margin; one or both lips with distinct teeth or plaits; animal with two tentacula, sessile eyes, but no operculum.

105

Geovula Sw. Oval; spire very short, turbinated, cancellated, of many whorls; apex obtuse; outer lip thickened internally; inner lip with a strong plait near the base. (*fig.* 105.)

G. Midæ. Griff. Cuv. 27. f. 8.

Pedipes Adans. Shell small, turbinate or sub-spiral; body-whorl ventricose; aperture on both sides defended by several teeth and plaits.

P. afra. Lowe, in Zool. Journ. v. pl. 12, f. 8—12.

Scarabus Montf. Shell depressed; spire as long as the aperture; umbilicus partly open; both lips with plaits, and tuberculous teeth.

S. imbrium. Sow. Man. f. 299.

Melampus Montf. Oval, sub-coniform; spire very short, obtuse; aperture narrow; inner lip thin, and striated internally; pillar plaited.

fasciatus. Gr. Cuv. 27. f. 13. exiguus *Lew.* Z. J. v. 12. f. 6, 7.

Rhodostoma Sw. General form of *Melampus* and *Tornatella*; but the aperture is not striated, and the inner margin of the lip is broad, considerably thickened, and distinctly notched towards the top.

coffea. Chem. 120. f. 1043. nucleus. Fér. Tab. Sys. 105.
fabula. Fér. Tab. Sys. 105. 24. 26.

Scissurella *D'Orbig.* Shell very small or minute; heliciform; spire depressed; aperture effuse; outer lip with a narrow fissure or slit; umbilicus open.

S. elatior. Sow. Man. f. 340.

Family NATICIDÆ.

Shell globose, generally smooth; spire minute, scarcely raised; aperture large, semicircular.

Sub-fam. 1. NATICINÆ. *Sea Snails.*

Shell globose;* inner lip smooth, not depressed.

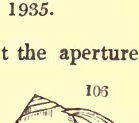
Natica *Lam.* Operculum shelly; shell globose; ventricose; umbilicus open, with a central gibbous ridge, or prominence.

N. lineata. Mart. 186. f. 1864, 1865.
millepunctata. Ib. 186. f. 1862, 1863.

Naticella Guild. Operculum horny; shell globose, but generally depressed; umbilicus nearly filled up with a vitreous deposition of the inner lip; spire obtuse.

? N. aurantia. Mart. 189. f. 1934, 1935.

Globularia Sw.† Shell not depressed, but the aperture very effuse; base of the body-whorl with a thickened belt; apex of the spire acute; recent and fossil. (*fig.* 106.)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sigaretina *Lam.* Coq. Foss. 13. f, 1.
patula. Ib. f. 2.
depressa. Ib f. 3.
acuminata. Ib. f. 4.
fluctuata. Griff. Cuv. 1. f. 4.
spirata. Coq. Foss. 13. f. 7.
crossitana. Ib. f. 8.

Mamillaria Sw. Shell oval, heavy; spire very small, pointed; inner lip considerably thickened at the top, and filling up a large umbilicus, placed near the base of the aperture; aperture effuse.

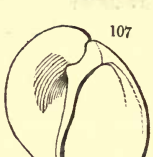
M. lactea *Sw.* Mart. 189. f. 1922, 1923.
tumida *Sw.* Ib. 189. f. 1928—1931.

Sigaretus Auct. Oval, flattened, ear-shaped; inner lip almost wanting; umbilicus none.

T. concavus. Lam. Hist. Nat. vi. 2. p. 208.

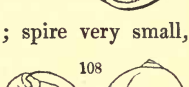
* The arrangement of this group, from ignorance of the animals of the major part, is purely artificial, being founded only on the shells.
† *Globulus* Sow.: altered, that the specific names may not be changed.

Naticaria Sw.* Oval; convex above; umbilicus small, open, placed very near the top of the aperture; inner lip reflected, small. (*fig.* 107.)


107

N. melanostoma. Mart. 189. f. 1926, 1927.
cancellata *Sw.* Ib. 189. f. 1939.
bifasciata. Griff. Cuv. 1. f. 2.

Lacuna Turton. Turbinate; thin; spire very small, of two whorls; the general shape is like *Natica*, but the base is contracted; umbilicus close to the top of the aperture, with a groove running on the margin of the pillar, which is oblique; operculum horny; aperture effuse, semicircular. (*fig.* 108.)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L. pallidula *Turton.* (*fig.* 108.)

Leucotis Sw. Form of the shell intermediate between *Sigaretus* and *Lacuna*; but there is no pillar; umbilicus large, pervious; inner lip thin, slightly reflected at the top; surface sculptured.

Sigaretus cancellatus. Lam. Sys. vi. 2. p. 207. Chem. 165. f. 1596. 1597.

SUB-FAM. ? NERITINÆ. *Nerits.*

Globose; spire very small; pillar oblique; inner lip very broad, depressed, more or less flattened, and generally toothed; aperture semicircular.

NERITA *Linn.* Shell solid; inner lip toothed or granulated.

N. peloronta. Mart. 192. f. 1977—1981. polita. Mart. 193. f. 2002, 2003.

Neritopsis Gray. Aperture sub-orbicular; pillar lip thickened above and below, with a wide notch in the middle. †

N. granosa. Sow. Man. f. 331.

* These are probably aberrant species, connecting *Sigaretus* with *Mamillaria;* but, until the whole are better understood, I think it advisable they should be kept distinct.

† Apparently related, by the shell, to *Leucotis.*

NERITINA *Lam.* General shape of *Nerita;* but the outer lip is thin and smooth, the inner one rather convex and crenated; surface smooth.

N. meleagris. Chem. 124. f. 1088. *a—i.*

Clithon Montf. Leach. General shape of *Neritina;* but there is an obtuse lobe on the inner lip, the outer is dilated at its origin, and the whorls are armed with spires.

C. corona. Chem. 124. f. 1083, 1084.

Velotes Mont. Nearly orbicular; depressed; above convex; beneath flat; spire nearly obsolete; inner lip toothed, as large as the aperture, which is semicircular.

V. perversa. Sow. Man. f. 326.

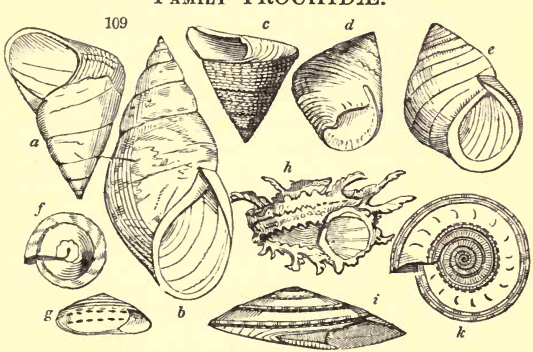
Pileolus Cookson. Shell above patelliform; spire internal; aperture beneath small, semilunar; outer lip margined; inner crenated.

P. plicatus. Sow. Man. f. 332.

Navicella Lam. Somewhat patelliform; oval; convex above; flat beneath; aperture large; inner lip narrow, thin, assuming the form of a plate across one end of the under surface; operculum shelly.*

N. elliptica. Sow. Man. f. 323.

FAMILY TROCHIDÆ.



* Unites the *Naticidæ* to the *Haliotidæ*, by *Crepidula.*

Shell turbinate, mostly trochiform *, the substance almost always perlaceous; outer lip never thickened; aperture entire, closed by a shelly or horny operculum.

Sub-fam. SENECTINÆ. *Snake Shells.*

Operculum round; calcareous; shell turbinate; the basal whorl ventricose; pillar always smooth; aperture round, rarely oblique.

110

Senectus *Humph.* Imperforate; the base produced into a broad flat lobe; spire rather elevated and pointed; the whorls convex; aperture perfectly round; not more oblique than *Helix*; inner lip entirely wanting. (*fig.* 110.)

imperialis. Mart. 180. f. 1790.
marmoratus. E. M. 448. f. 1.
pethiolatus. Mart. f. 1777-8.
cornutus. Ib. 179. f. 1779-80.
setosus. En. Méth. 448. f. 4.
argyrostomus. Mart. f. 1766.
chrysostomus. Ib. f. 1766.
radiatus. Mart. f. 1788-9.
margaritaceus. Ib. f. 1762.
Sprenglerianus. Ib. f. 1801-2.
crenulatus. Ib. f. 1811-12.
hippocastanum. Ib. f. 1807-10
coronatus. En. M. 448. f. 2.
angulatus *Sw.* Sow. Gen. f. 8.

Marmarostoma *Sw.* Umbilicus deep; spire of few whorls, much depressed, and obtuse; inner lip obsolete; base even more produced than in *Senectus*, but never distinctly channeled.

M. versicolor. Mart. 176. f. 1740, 1741.
undulata. Chem. 169. f. 1640, 1641.

Delphinula Lam. Turbinate; spire depressed, the tip obtuse; pillar almost entirely wanting; the umbilicus being large and pervious; exterior of the shell rough with tubercles or lamellar plates. (*fig.* 109. *h.*)

torquata. Mart. Conch. 2. f. 71.
lamellosa. Zool. J. v. p. 331.
laciniata. En. Méth. 451. f. 1.

Cyclocantha† *Sw.* Sub-depressed, trochiform; im-

* Except *Phasianella.*
† Resembles *Tubicanthus*, but the aperture is hardly perlaceous, the body-whorl not flattened beneath, or the mouth oblique.

perforate; both sides compressed; substance of the shell not perlaceous, but convex; mouth slightly oblique; lips united; base not produced: doubtful type.

stellaris. Mart. 164. f. 1553-4. calcar. En. Méth. 451. f. 2.

CIDARIS *Sw.* Perlaceous; turbinate; generally smooth; the base not produced; the inner lip not concave; always imperforate; aperture round, but oblique; operculum very thick: representing *Calliostomus.*

sarmaticus. Mart. 179. f. 1777, 1778.
smaragdus. En. M. 448. f. 3.
E. coronatus. *Sw.* Chem. 165. f. 1585, 1586.
pethiolatus. Mart. 183. f. 1826.
pictus *Sw.* En. Méth. 448. f. 5.
ater *Sw.** Sow. Gen. f. 7.

SUB-FAM. TROCHINÆ. *Trochus, or Top.*

Shell trochiform; the body-whorl more or less wide, and flattened beneath; the spire conical or pyramidical; aperture oval, wider than it is high; operculum horny.†

CANTHORBIS. Operculum shelly; aperture very oblique, broad, and narrow; the basal whorl much flattened; pillar, in the typical examples, twisted: representing *Cerithium.*

Tubicanthus Sw. Turbinate; aperture oval, effuse; very oblique; inner lip broad, concave, spreading, united to the outer lip; base of the pillar simple, blended with the circumference of the aperture.‡

rugosus. Mart. 180. f. 1782—1785.
cælatus. Ib. 162. f. 1536.
Tuber. Mart. 165. f. 1373.
Cookii. Ib. 163. f. 1540.
imbricatus. Id. 162. f. 1531.

Canthorbis Sw. *Suns.* Nearly disk-shaped: spire but slightly raised; the margin of the body-whorl flattened, and serrated with flat spines; inner lip united to the outer; pillar and aperture as in the last.

C. imperialis. Mart. 173. f. 1714.

* Is this the *Turbo lugubris*? Zool. Journ. v. 345.

† Except in the first genus, which connects this sub-family and the *Senectinæ*, and in *T. Niloticus* (as it is said), which connects *Canthorbis* with *Trochus.*

‡ Connected to *Cidaris* by *C. rugosus.*

Pyramidea Sw. Imperforate; spire much elevated, pyramidical, acute; basal whorl beneath much flattened, and scarcely convex; pillar spiral, the base very short, turning inwards, and then outwards, but smooth; outer lip thin; inner wanting.* (*fig.* 109. *c.*)

obalisca. Mart. 160. f. 1511, 1512.
foveolata *Gm.* Mart. 161. f. 1516, 1517.
Nilotica. Mart. 168. f. 1614.
virgata. Ib. 160. f. 1514.
marmorata. Ib. 167. f. 1606.
Mauritiana. Ib. 163. f. 1547.

Lamprostoma Sw. Umbilicated; pyramidical, spire elevated, acute; basal whorl much flattened beneath, slightly convex; pillar spiral; the base short, and marked by distinct plaits; aperture striated; inner lip wanting.

L. maculata. Mart. 168. f. 1515, 1516.

Carinidea Sw. Imperforate; spire pyramidical, acute; basal whorl concave beneath, and carinated round its circumference; aperture oval, entire, slightly angulated at the base of the pillar, which turns inwards.

C. concavus. Mart. 168. f. 1620, 1621.
brevispinus. ? Sow. Gen. (*Turbo.*) f. 1.

Trochus *Linn.* Operculum horny; shell trochiform; the basal whorl broad; aperture oval; sometimes angulated by the union of the pillar and the outer lip, but rarely toothed or striated.†

Chlorostoma Sw. Deeply umbilicated almost to the top of the spire; inner lip forming a semi-margin to the umbilicus; outer lip angulated at the base, with one or two tubercles; body-whorl almost flat beneath, and nearly carinated at its edge; aperture remarkably oblique: representing *Monilea.*‡

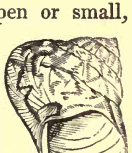
C. argyrostoma. Mart. 165. f. 1362, 1363.
umbilicaris. Ib. 171. f. 1666.

* *Troch. Niloticus* is probably osculent between this and *Lamprostoma*; but I have not seen a thoroughly full-grown specimen, with the mouth quite formed: the operculum is said to be horny; but this may be doubted.

† Except in *Trochidon*, which represents *Monodonta* Lam. in this circle.

‡ *Troch. merula* Lam. connects this sub-genus with *Pagodella.*

Trochus Linn. Umbilicus either very open or small, but always apparent; base of the outer lip sinuated where it unites with the pillar; inner lip generally spreading, flattened, and concave; body-whorl convex beneath, rounded on the sides; aperture obliquely round; spire short, depressed, pointed. (*fig.* 111.)



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T. pica. Mart. 176. f. 1750.
magus. Ib. 171. f. 1656.
cinerarius *Linn.* Mart. 171. f. 1686.

Pagodella Sw. Trochiform; generally thin, and always not perlaceous; aperture and pillar perfectly united and entire; operculum horny.

P. major. Mart. 163. f. 1541, 1542.
tectum-persica. Ib. f. 1543, 1544.

Trochidon Sw. Trochiform; spire more elevated than in the last; but the base of the pillar either angulated, umbilicus none, or forming a tooth more or less developed, often with a lateral, depressed groove, but no umbilicus; margin of the outer lip thin, the inside rarely striated. (*fig.* 109. *d.*)

T. labeo. En. Méth. 447. f. 1.
viridis. Ib. 447. f 2.
canalifera. Ib. f. 5.

Calliostoma Sw. Imperforate: spire elevated, acute; aperture broader than high, transversely ovate, hardly sinuated at the base, and slightly oblique; shells always smooth, and often polished: representing *Cidaris.*

zizyphina. Pen. Zool. pl. 80. f. 103.
conuloides. Lam. No. 47.
conula. Mart. 166. f. 1588.
erythroleuca. Ib. 162. f. 1529.
annulata. Ch. 165. f. 1551-2.
doliata. Ib. f. 1579—1583.
granatina. Mart. 170. f. 1654, 1655.
Australis. Zool. Jour. v. 331.

Monodonta *Lam.* Base of the pillar forming a distinct tooth; umbilicus deep*, with a deep groove below; aperture striated; outer lip not thin at the margin.

Elenchus Humph. Shell smooth; spire considerably

* Except in *Elenchus* and *Echinidea.*

lengthened; body-whorl comparatively smaller; base of the pillar with a slight angle, or an obsolete tooth; aperture smooth, very brilliant; passing into *Calliostomus.*

E. Iris. Mart. 161. f. 1652, splendidulus. Sw. Sp. Nov.* 1653. (*fig.* 109. *a.*)

Echinella Sw. Shell imperforate, granulated, not perlaceous; spire considerably lengthened; pyramidical; base of the pillar with a distinct tooth; aperture striated: representing *Pagodella.*

E. granulata. Sw. Sp. Nov. coronaria. En. Méth. 447. f. 6.

Monodonta Lam. Turbinated; in general umbilicated, having a groove below, and a tooth at the base of the pillar; aperture nearly round, striated within; umbilicus never toothed: representing *Senecus* and *Trochidon.*

M. retusa. En. Méth. 447. f. 4.

Fragella Sw. Trochiform; umbilicus deep, always open, and toothed round its margin; base of the pillar twisted, and forming a tooth-like process at its tip: representing *Trochidon.*

Pharaonis. En. M. 447. f. 7. Sowerbyana. *Sw.* Sow. Gen. undata. Ib. 447. f. 3. f. 9. 11. (*Trochus.*)

Monilea Sw. Umbilicus deep and wide, but the edges quite smooth, with a thickened half margin, formed by the inner lip, which terminates abruptly; base of the outer lip with one or two tubercles, or obsolete teeth; margin of the whorls concave; inner lip often striated: representing *Chlorostoma.*

M. callifera? Lam. Sys. 27. No. 59.

Solarium *Lam.* Shell nearly discoid, not perlaceous; spire none; aperture angulated, smooth within; the edge acute; the lips wanting. (*fig.* 109. *i, k.*)

S. perspectivum. En. Méth. 446. f. 1.

Onustus *Humph.* Shell trochiform; the surface irregular, and often covered with extraneous bodies

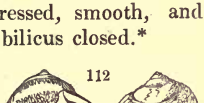
* Small, entirely fawn colour, or light brown; aperture of the most brilliant purple and emerald green. Australia.

cemented and incorporated with the calcareous substance of the shell; the under part of the body-whorl flattened or concave, umbilicate.

O. Solaris. Mart. 173. f. 1700, 1701.
Indicus. Ib. 172. f. 1697, 1698.

Sub-fam. ROTELLINÆ.

Substance perlaceous; shell depressed, smooth, and highly polished; mouth thin; umbilicus closed.*

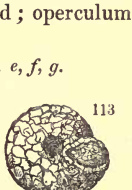


Chrysostoma *Sw.* Shell turbinate; the whorls few and convex; aperture effuse, round; inner lip thickened, just over and almost concealing the umbilicus.

Nicobaricus. Mart. 182. f. 1822–1825. (*fig.* 109.)

Rotella *Lam.* Shell flattened, nearly discoid, polished; inner lip very thick, and spreading over half of the under surface; aperture small, angulated; operculum horny. (*fig.* 109. *f, g.*)

R. lineotata *Lam.* Mart. 166. f. 1601. *e, f, g.*



Thelidomus *Sw.* (*fig.* 113.) Turbinate, sub-trochiform; umbilicus large, open; the whole shell entirely composed of grains of sand.

Braziliensis *Sw.* (*fig.* 113.)

Sub-fam. PLEUROTOMARIÆ.

Trochiform; the aperture with a slit or fissure. Fossil only.

Pleurotomaria *Defrance.* Spire more or less elevated. Being only found in an imperfect or fossil state, nothing has been determined as to the umbilicus, substance, operculum, &c.

P. reticulata. Sow. Gen. t. 1.

* These have probably no operculum, and *Rotella* may be an internal shell.

Sub-fam. PHASIANELLINÆ.

Obovate, spiral, polished; aperture oval; spire longer than, or equal to, the aperture; operculum shelly.

Phasianella *Lam.* Umbilicus none. (*fig.* 109. *b.*)
P. bulimoides. En. Méth. 449. f. 1. *a—c.*

Family HALIOTIDÆ. *The Ear-Shells.*

Shell disk-shaped entire; the spire nearly obsolete, depressed, convolute, mostly lateral, and of only two or three minute whorls; pillar none; operculum none.

Haliotis *Linn.* Iridescent; ear-shaped; a row of perforated holes on the thickest side of the aperture. The sub-genera remain to be determined.

Stomatia *Lam.* Oval or oblong; the shell resembling *Haliotis*, but without perforations.
The types of form are enumerated at page 232.

Calyptræa *Lam.* Shell not perlaceous; patelliform, but with the first rudiments of an internal support, and often of a spire.

Bicatillus Sw. Shell patelliform; spire or whorls none; a cup-shaped appendage within, more or less complete.
B. extinctorium *Sw.* Sow. Gen. f. 3. deformis. Ib. f. 1.

Calyptræa Lam. Patelliform; internal appendage half funnel-shaped, but open in front.
C. equestris *Lam.* Sow. Man. f. 234. Sow. Gen. f. 2.

Haliotidea Sw. Spire prominent, formed of two whorls, and placed laterally; umbilicus open.
sigaretoides.* *Sw.* dilatata? Sow. Gen. f. 9. (*Calyptræa.*)

* This sub-genus seems to form, with certain *Vetulinæ*, the passage to our *Chelinotus*, or the *Sigareti* of authors.

Trochilla Sw. Shell conical, patelliform ; spire central, of two or more whorls ; umbilicus closed.

T. auriculata. Sow. Man. f. 236. pileus. Ib. f. 237, 238.

Biconia Sw. Patelliform, conical ; internal appendage forming a funnel-shaped fold, not open in front ; apex central, sometimes with the vestige of a whorl.

Humph. Conch. f. 11. and 12.

Chelinotus *Sw.* Animal cheloniform, broad ; depressed ; the mantle much larger than the shell, lobed in front ; tentacula two, short, obtuse ; eyes basal ; mouth circular ; shell ear-shaped, thin, fragile, imperforate ; pillar none.

Velutina Lam. Animal — ? fragile ; shell with the two spiral whorls raised, so as to resemble a *Lymnia* ; no pillar ; epidermis thin, horny.

lævigata. Sow. Man. f. 337.

Chelinotus Sw. Shell thin, diaphanous, white, entirely concealed in the back of the animal, which is marked with hexagonal partitions.

Sigaret de Tonga. Quoy, Voy. d'Astrolabe.

Coriocella Blainville. Animal broad oval, with the anterior lobes not prolonged, or the back divided as in the last ; shell thin, flexible, membranaceous.*

C. niger *De Blainville.* Man. de Malac. pl. 42. f. 1.

Crepidula *Lam.* Shell boat-shaped ; the apex or spire at the narrowest extremity : half of the internal cavity covered by a testaceous plate.

C. fornicata. Sow. Gen. f. 1. aculata, Ib. f. 5.

Tribe 3. SCUTIBRANCHIA. *The Limpets.*

Shell patelliform or cup-shaped ; without any spire or internal support.

Fissurella *Lamarck.* An oval aperture at the apex, or highest part of the shell.

* Griff. Cuv. xii. 68.

Fissurella. Apex nearly central; aperture large, oval simple.

F. picta. Sow. Gen. f. 1. gigas. Sw. Sp. Nov.

Machrochisma Sw. Aperture very large, oblong, placed closed to the margin.

M. hiatula *Sw.* Sow. Gen. f. 5.

Clypidella Sw. One extremity of the shell, near the perforation, slightly raised, truncated, and sub-emarginate.

C. pustula. Sow. Gen. f. 3.

Fissuridea Sw. Sub-conical, cap-shaped; the summit close to the posterior margin; the perforation narrow.

T. pileus. Sw. Sp. Nov.

EMARGINULA *Lam.* Either patelliform or cap-shaped; the apex near the posterior end; the anterior margin or summit with a very narrow slit or fissure.

Emarginula Lam. Cap-shaped; fissure on the anterior margin.

E. reticulata. Sow. Gen. f. 5. fissura. Sow. Man. f. 241. elegans. Ib. f. 4.

Cemoria Leach. Cap-shaped; fissure down the centre of the apex.

C. Flemingii. Sow. Man. f. 244.

Rimula Def. Cap-shaped; fissure long, in the middle of the shell; margin entire.

R. Blainvillii. Sow. Gen. f. 243.

Parmophorus Lam. Patelliform; fissure assuming the form of an anterior sinus, scarcely perceptible on the anterior margin.

P. elongatus. Sow. Gen. f. 1. breviculus. Sow. Gen. f. 2.

Hemitoma Sw. Patelliform; the fissure not cut through the shell, but merely forming an internal groove.

H. tricostata *Sw.* Sow. Gen. f. 6.

HIPPONYX. Shell cap-shaped; the apex sometimes

produced and slightly curved inwards; muscular impression semi-circular.

Hipponyx De Fr. Cap-shaped or patelliform; strong; the margins thick, and reposing upon a thin, flattened; testaceous plate, forming a second valve.

cornucopia. Sow. Man. f. 199.

Pileopsis Lam. Shell cap-shaped; thin; the apex much produced and incurved; no basal support or internal appendage.

P. Hungaricus. Sow. Man. f. 240.

PEDICULARIA *Sw.* Shell irregular, sub-patelliform; a thick, large, obsolete apex on one of the longest sides, and an internal callous rim within, on one side only; circumference undulated, irregular.

P. Sicula *Sw.* (*fig.* 44.)

PATELLA *Linn.* Shell entire, simple, cup-shaped or patelliform; apex pointed, entire.*

P. miniata. Sow. Gen. f. 2.

Siphonaria Sow. One side more dilated than the other, and marked by an internal groove.

S. Sipho. Sow. Gen. f. 1.

TRIBE 4. CYCLOBRANCHIA. *The Chitons.*†

Animal patelliform, oval; the mantle coriaceous; the back covered with imbricate shelly plates; no tentacula.

CHITON *Lin.* Back with large transverse plate; zone, or mantle, wide, covered with small scales, either imbricate or reticulate.

C. squamosus. Sow. Gen. f. 2.

CANTHAPLEURA *Guild.* Plates as in Chiton; the

* The fresh-water genus *Ancylus* has the same shaped shell, but the animal shows it belongs to the *Limnianæ*.

† Not having analysed this tribe, I have adopted the genera and arrangement of Guilding, see *Zool. Journ.* xvii. p. 27., especially as they thus form a circular group.

mantle rough, with moveable spines, prickles, setaceous hairs, or granules.

C. spinosus. Sow. Gen. f. 1.

PHAKELLOPLEURA *Guild.* Plates moderate; the mantle ornamented with a single series of tufts of radiating hairs.

P. fascicularis. Sow. Gen. f. 3.

CHITONELLUS *Lam.* Body larvæform; plates small, detached; mantle naked; sides with punctures, resembling spiracles.

C. larviformis *Burrows.* latus *Guild.* Z. J. xvii. p. 78.

CRYPTOCONCHUS *Blainv.* Plates moderate, entirely covered with the soft down of the zone, each plate having two lateral and tabular pores, and four on the anterior plate.

C. porosus *Burrows.*

TRIBE 5. TECTIBRANCHIA. *The Sea Slugs.*

Body naked; branchia generally covered by a coriaceous or testaceous plate, or oviform shell, which is more or less concealed in the mantle, or its lobes; eyes sessile, minute.

SUB-FAM. 1. PHYLLIDINÆ.

Shell none; body shaped as in *Chiton;* mantle coriaceous; branchia folliculated, placed on both sides of the body, under the edges of the mantle; tentacula small, short, two or four.

PHYLLIDEA *Cuv.* Shape oval; tentacula four, the upper pair cylindrical and pointed, the under very small, inferior, and placed on the side of a small mouth.

P. pustulosa. Rüpp. Atlas, i. pl. 7. f. 1.

DIPHYLLIDEA *Cuv.* Posterior end narrowed; tentacula two, the inferior pair represented by two tubercles.

D. lineata *Otto.*

Sub-fam. 2. APLYSIANIÆ. *Sea Hares.*

Mantle dilated, undulated at its edges and thrown on the back; branchia dorsal, pectinated, generally covered with a convex, irregular, horny, or calcareous plate; tentacula two or four, ear-shaped.

Aplysia *Linn.* Animal with a short neck; tentacula four, the upper and large pair flat, and folded so as to resemble the ears of a hare; mantle very large, and sufficiently dilated for swimming.

fasciata. Rang. Ap. pl. 6, 7. Argus. Rüpp. Atl. i. pl. 7.

Thallepus *Sw.* Body more slender and fusiform; the lobes of the mantle short, and incapable of being used for swimming; tentacula two, large, ear-shaped; eyes not visible.

T. ornatus *Sw.* Sp. Nov. See page 250.

Dolabella *Lam.* Body pyriform, very broad behind; the lobes compactly folded on a hatched-shaped calcareous shell, which covers the branchia.

D. Rumphii *Lam.* Blainv. Man. pl. 43. f. 5.

Bursatella *Blainv.* Body nearly globular; the dorsal edges of the mantle united together, but leaving a short opening for the passage of the water to the branchia, which have no covering.

B. Leachii *Blainv.* Man. pl. 43. f. 6.

Notarchus *Cuv.* Body shaped much like that of *Aplysia,* covered with flat palmated lobes or membranes; tentacula two, large and palmated; mantle and branchia as in *Bursatella.*

N. laciniatus. Rüpp. Atl. i. pl. 7. f. 2.

Sub-fam. 3. BULLINÆ. *The Bullas.*

Animal without apparent tentacula; body oblong; both extremities obtuse; eyes vertical, very minute; branchia dorsal, covered by a convolute shell, destitute of

any spire; the base widest: this in the typical species, is covered by the lobes of the mantle; in others the whole animal is contained in the shell.*

Bullæ Lam. Shell internal, oval, colourless; inner lip thin; apex umbilicated; animal oblong, without tentacula.

aperta. Sow. Man. f. 248. ? Guildingii *Sw.* (See *fig.* 46.)

Bulla. Animal furnished with two connected bony plates; shell obovate; contracted above, and effuse at the base.

B. Lignaria. Sow. Man. f. 251.

Vesica Sw. Animal unknown? probably contained within the shell; shell oval, solid; apex umbilicated; aperture entire; contracted above.

ampulla. Sow. Man. f. 252. Naucum. Sow. Man. f. 250.

Aplustra Schum. Animal ——? shell solid, but thin; furnished with a distinct but depressed spire.

A. fasciata. Sow. Man. f. 249.

Bullinula Beck. General shape of the last; but the spire is slightly produced and conic: a doubtful type?

B. lineata. Sow. Man. f. 253.

Vitrella Sw. Animal —— ? shell internal, hyaline, or sub-transparent; convolute; the apex carinated; the substance elastic.

V. fragilis. Sow. Man. f. 247.

Doridium *Mecken.* Animal with the lobes dilated into fin-like processes, but without a shell.

D. carnosa. Cuv. Mém.

Sub-fam. 4. GASTEROPTERIDÆ.

Gasteropteron *Meck.* Animal short, ovate, natatorial; the margins of the foot dilated into broad wing-like

* The arrangement of this sub-family, founded chiefly upon the shell, is purely artificial, no knowledge having been gained of the greater part of the animals. Such genera as *Cryptella*, &c., founded merely upon the branchial covering of some unknown animal, can never be admitted into Malacology.

lobes; shell none; branchia naked, placed on the right side of the body.

G. Meckelii. Blainv. Man. de Malacol. pl. 45. f. 3.

Sub-fam. 5. PLEUROBRANCHINÆ.

Animal cheloniform, branchia pectinated, placed on the right side under the edge of the mantle which sometimes covers a calcareous shell.

Umbrella Lam. Animal large and circular; anus tubular, placed behind the branchia; tentacula two, short, as in the next genus; with eyes at the internal base, between which is a proboscis. Shell resembling a limpet; but the middle is thickest, and the edges very sharp.

U. Indica. Blainv. Man. pl. 44. f. 1.

Pleurobranchus *Cuv.* Animal cheloniform; body overlapped by the mantle and the foot; the former sometimes contains a small oval plate, either horny or calcareous; mouth small, prosbosciform; tentacula two, tubular, and short.

citrinus. Rüpp. Atl. i. 5. f. 1. Forskalii. Ib. pl 5. f. 2.

Pleurobranchæa *Meckel.* Anus above the branchia; tentacula four, short, remote; shell none; branchia and genital orifices as in the last.

Meckelii. Leve. Dissert. Griff. Cuv. xii. 43.

Order DITHYRA. *Bivalve Shells.*

Tribe 1. TUBULIBRANCHIA *Cuv.*

Animal inhabiting a tubular shell affixed to other substances and somewhat spiral at its tip; tail turned under the body and terminated by a thin operculum; head obtuse, with two short tentacula with sessile eyes; mouth a vertical orifice with two filaments beneath belonging to the foot; hermaphrodite.*

* The animal of *Magilis* being unknown, I am afraid of including it in this group.

VERMETUS. Shell tubular, contorted; the terminal whorls spiral.

G. lumbricalis. Sow. Man. f. 345.

VERMILLIA *Lam.* The terminal whorls not spiral.

V. triquetra. Sow. Man. f. 7.

SILIQUARIA *Brug.* Terminal whorls spiral; a narrow punctured fissure on one side of the shell.

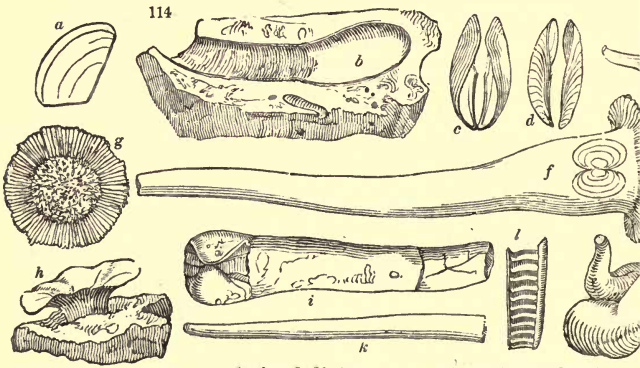
S. anguina. Sow. Man. f. 1.

TRIBE 2. MACROTRACHIÆ.

Animal with one or two long respiratory siphons, either distinct or united; the margins often furnished with little teeth.

FAMILY 1. PHOLIDÆ.

Shell bivalve, sedentary, generally perforating, opening at one or both ends; the valves often prolonged into a shelly tube, sometimes of great length: representing the *Tubulibranchia.*



ASPERGILLIUM. Animal living in sand, and not fixed on or upon any other substance: inhabiting a calcareous tube.

Aspergillium Lam. Shell tubular, nearly straight, one

extremity open, at the other closed by a plate which is perforated with small holes, near to which are the bosses: lives in sandy shores. (*fig.* 114. *f, g.*)

A. vaginiferum *Lam.* Sow. Gen. f. 1. 2.

Clavagella Lam. Two irregular valves placed within a short shelly tube, dilated at its open extremity, and to which one valve is fixed or soldered at the other: perforates stones, &c. (*fig.* 114. *a, h.*)

C. aperta. Sow. Gen. f. 1—4.

Fistulana Lam. Animal not perforating; tube purse-shaped, straight, the narrow extremity open, the other closed; a transverse septum crosses the tube, and incloses at its largest end a bivalve shell, which is elongated, solen-shaped, gaping widely at the basal margin, and united by a ligament. (*fig.* 114. *m.*)

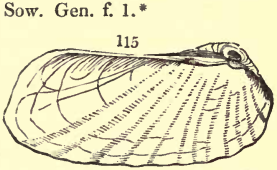
F. clava. Sow. Gen. f. 1—4.

GASTROCHINA *Lam.* Animal perforating or parasitic; tube calcareous, clavate, nearly divided longitudinally for half its length by an internal ridge, which forms a double aperture; the other or thick extremity encloses an ovate bivalve shell, gaping very wide anteriorly; hinge linear and marginal; teeth none. (*fig.* 114. *b, c, d.*)

G. modiolina. Sow. Gen. f. 1.*

PHOLADOMYA *Sow.* Shell not tubular, pholas-shaped, perlaceous, slightly gaping, no accessary valves; ligament short; external hinge with a small elongated pit somewhat triangular, and a marginal plate on each valve; umbones very close.

115



P. candida. Sow. Gen. Man. f. 57. (*fig.* 115.)

PHOLAS *Linn.* Animal perforating but not tubular;

* I consider the perforating species to be types of a different sub-genus; and probably those which are parasitic upon other shells should likewise be separated.

shell free, oblong-ovate, thin, with an internal compressed tooth in each valve and accessary pieces.

Pholas Linn. Shell gaping at both extremities over the umbones; ligament none. (*fig.* 122. *f.*)

P. dactylus. Sow. Gen. f. 1.

Pholidæa Leach. Resembling *Pholas*, but the anterior end is closed by a thin calcareous prolongation of each valve, and the posterior end has a cup-shaped appendage. (*fig.* 122. *g.*)

T. papyracea. Sow. Gen. f. 3. Man. f. 56.

Martesia Leach. General characters of *Pholas*, but both extremities are closed.

M. clavata *Auct.* (*fig.* 122. *i.*)

Xylophaga Sow. Habit of *Pholas*; but the shell is orbicular, widely gaping anteriorly, and with accessary valves; each valve with an incurved tooth, and an internal transverse rib.

dorsalis. Sow. Man. f. 50, 51.

TEREDO *Linn.* Shell tubular, irregular; the valves pholas-shaped, short and nearly orbicular.

Teredo Linn. Valves resembling *Xylophaga*; placed at the thickest extremity of a long, irregular tube, "which is open at both ends, the anterior end divided into two apertures furnished with two opercula."* (*fig.* 114. *k*, *l.*)

T. navalis. Sow. Gen. Man. f. 48, 49.

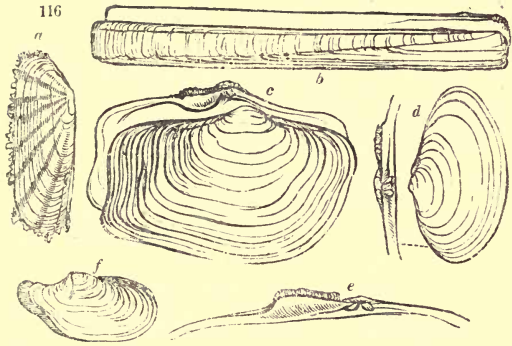
Teredina. Tube clavate, irregular, nearly divided into two, by a projection on each side within, thus forming a double opening at the smallest extremity; valves as in *Teredo*, but wholly external, *incrustated* with the tube, and having accessary valves.

T. personata. Sow. Gen. Man. f. 46, 47. (*fig.* 114. *i.*)

* I have not leisure to look into these characters, and have therefore adopted Mr. Sowerby's account of this and the next genus.

Family 2. MYADÆ. *Gaping Bivalves.*

Shells regular, always with defined cardinal teeth; valves more or less gaping at one or both extremities.



Sub-fam. SOLENINÆ. *Solens.*

Shells generally linear, and always open at both extremities; cardinal teeth distinct.

Solen *Linn.* Shell very straight, broad, linear, and of equal length throughout; umbones very small, terminal; cardinal teeth small; ligament long, external.

truncatus. Sow. Gen. f. 1. vagina. Ib. f. 2. (*fig.* 116. *b.*)

Ensatella *Sw.* Shell slightly curved.

E. Europea *Sw.* (*Solen Ensis* Auct.)

Novaculina *Benson.* Straight, of equal length throughout; the extremities rounded; umbones towards the middle; cardinal teeth $\frac{2}{1}$; dorsal margin slightly thickened.

N. Gangetica. Sow. Man. f. 63.

LEPTON *Turton.* Small, nearly round; umbones central; teeth ——? The cardiform type.

L. squamosus. Sow. Man. f. 62.

SOLENOCURTIS. Shell depressed, thin, transverse, oblong ovate; the valves slightly gaping at one extremity; cardinal teeth and umbones nearly central.

Solenella Sow. Oval, compressed; epidermis glossy; hinge margin nearly straight; cardinal teeth wanting; posterior lateral teeth numerous, sharp; anterior end somewhat truncated: representing *Nucula.*

S. Norisii. Sow. Man. f. 138.

Solenocurtis Blainv. Oblong-ovate, nearly linear; umbones small, nearly central, with a thickened internal transverse ridge; ligamental margin much thickened. (*fig.* 116. *e.*)

S. radiata. Sow. Man. f. 61. Blainv. Man. pl. 80. f. 1.

Sanguinolaria Lam. Ovate, compressed; posterior end sub-rostrated; anterior rounded; cardinal teeth small, $\frac{2}{2}$. (*fig.* 116. *d.*)

S. rosea. Sow. Man. f. 98.

Glauconome Gray.* Obovate, not gaping, sub-ventricose, and rounded anteriorly, narrowed and compressed posteriorly; cardinal teeth $\frac{3}{3}$, some of which are bifid; ligament oblong; external epidermis extending over the margin; fluviatile: apparently representing *Mactra* in this genus,

G. chinensis *Gray.* Sow. Man. f. 64.

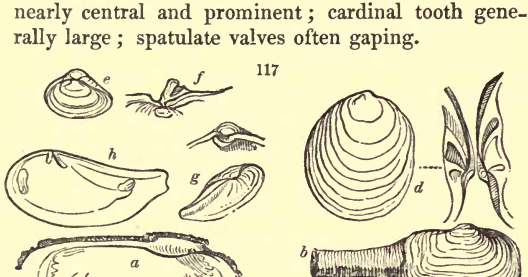
Solenymia Lam. Shape of *Solenocurtis,* but somewhat cylindrical; umbones very small, and placed laterally; hinge margin straight; valves gaping on their anterior end; cardinal teeth $\frac{1}{1}$, dilated and compressed, with a callous ridge between; ligament

* I have not seen this shell, which, from the figure quoted, has exactly the shape of *Unio ovata.*

internal and external: representing *Pandora* and *Glycymeris*. Epidermis thin, shining, dilated.

S. Mediterranea. Sow. Gen. f. 112. (*fig.* 116. *a.*)

MYA *Linn.* Shell thick, ventricose, ovate, transverse, one end truncated and gaping; umbones generally nearly central and prominent; cardinal tooth generally large; spatulate valves often gaping.



Anatina Lam. Hyaline, thin; cardinal tooth spoon-shaped, sometimes with a transverse internal appendage, or plate, like an additional tooth. (*fig.* 116. *f.*)

M. subrostrata. En. Méth. 228. f. 3.

Mya Linn. Shell thick, strong; cardinal tooth spatulate; both extremities gaping*; cardinal teeth $\frac{1}{0}$.

M. truncata. En. Méth. 229. f. 2. (*fig.* 117. *b, c.*)

Panopia Lam. Resembling *Mya*; cardinal teeth $\frac{1}{1}$, acute; ligamental margin greatly thickened; ligament external. (*fig.* 116. *c.*)

P. Aldrovandi. Sow. Man. f. 65.

Corbula. Inequivalve, ovate; umbones central, one more prominent than the other; valves not gaping; cardinal teeth $\frac{1}{1}$, bearing the ligament: leading to *Mactra*. (117. *e, f.*)

Sulcata. En. Méth. 230. f. 1. C. nucleus. Sow. Man. 89.

* Connected to *Anatina* by *Anatina rupicola* Lam.

Pandora Lam. Inequivalve, thin, rostrated, perlaceous; one valve flat, the other convex; ligament internal; umbones small; cardinal teeth $\frac{2}{0}$, lamellar, sagittate, or like a V reversed: connected to *Anatina*. (*fig.* 117. *g*, *h*.)

P. rostrata. En. Méth. 251. f. 1.

Mactra *Linn.* Equivalve; the valves slightly gaping on one side; ligament internal and external; cardinal teeth complicated.

Lutraria Lam. Shell thin, transversely oval or oblong; cardinal teeth $\frac{2}{3}$, angular, followed by a spoon-shaped lobe containing the cartilage; lateral teeth none. (*fig.* 118. *b*.)

L. compressa. En. M. 257. f. 4. papyracea. Sow. Gen. f. 2.

Mactra Linn.* Transversely oval or sub-trigonal; umbones prominent; cardinal teeth $\frac{2}{2}$, angular, some-

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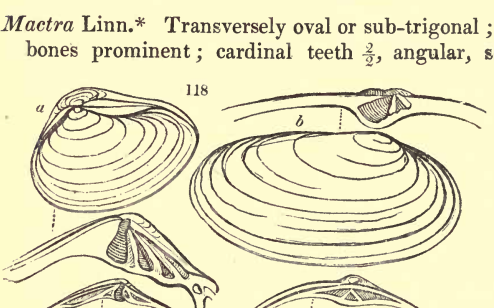


times with additional laminæ; cartilage entirely internal, nearly central; lateral teeth $\frac{1}{2}$. (*fig.* 118. *c*.)

Neapolitana. Poli. Test. pl. 18. f. 1—5. stultorum. En. M. 265. f. 2. turgida. Sow. Gen. f. 2.

Schizodesma Gray. General character of *Mactra*; but

* Including *Mactra bicolor*, &c., Auct.

the umbones are remote; the ligament placed in an external slit; the lateral teeth very short and small, and the cardinal teeth nearly obsolete.

S. Sprengleri. En. Méth. 252. f. 3.

Hemimactra Sw. General form of *Mactra;* but the cardinal teeth entirely wanting; cartilage internal, central, in a large triangular cavity; lateral teeth $\frac{0}{1}$, distinct, lamellar, striated: connected to the *Glycuneri.*

H. gigantea *Lam.* v. 472. No. 1. grandis *Sw.* Sp. Nov.

Crassatella Lam. Shell solid, heavy, not gaping, more or less rostrated; hinge very thick; cardinal teeth $\frac{0}{2}$ sub-angular, striated, and placed on one side; immediately beneath the umbones is a triangular cartilage; lateral teeth obsolete: representing *Pandora, Trigonia, Placuna,* &c.

C. Kingicola *Lam* (*fig.* 118. *a.*) rostrata. Sow. Man. f. 84.

Glycimeris *Lam.* Oblong, transverse; both extremities gaping; cardinal and lateral teeth entirely wanting; but the hinge margin very thick; ligament large, external: representing *Solenimya,* and connected to *Solen* by *Novaculina.**

G. Siliqua. Sow. Gen. (*fig.* 118. *b, c.*)

Family TELLINIDÆ. *Solid and close Bivalves.*

Shell never gaping†; equivalve; the margins thickened and solid; rarely covered with an epidermis; cardinal and lateral teeth well developed.

Sub-fam. 1. CYCLINÆ.

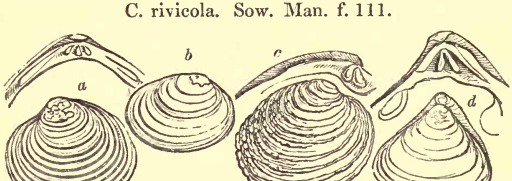
Animal generally fluviatile; shells covered by an epidermis.

Cyclas‡ *Lam.* Shell thin, transversely ovate, equila-

* The four other sub-genera are unknown. † Except in *Psammobia.*
‡ Including *Pisidum.*

teral; cardinal teeth small; lateral teeth $\frac{2}{2}$, long, compressed; ligament external. (*fig.* 119. *b.*)

C. rivicola. Sow. Man. f. 111.



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Cyrena *Lam.* Shell thick, transversely ovate, nearly equilateral; cardinal teeth $\frac{3}{3}$; lateral teeth $\frac{0}{2}$, short, thick, obtuse; fluviatile and marine. (*fig.* 119. *a.*)

C. Sumatrensis. Sow. Gen. 1—4.

Megadesma *Bowdich.** Shell thick, trigonal, nearly equilateral; cardinal teeth $\frac{2}{2}$; lateral teeth obsolete; hinge very thick; ligament external. (*fig.* 119. *d.*)

M. radiata. Sow. Man. f. 115.

Gnathodon *Gray.* Shell transversely obovate, inequilateral; bosses thick, prominent, remote; cardinal teeth $\frac{1}{2}$; lateral $\frac{2}{0}$; cartilage internal, placed by the side of the cardinal teeth.

G. cuneatus. Sow. Man. f. 83.

Cumingia *Sow.* Shell transversely obovate; hinge with a spatulate cavity filled by the cartilage; cardinal teeth $\frac{1}{1}$, very small; lateral teeth $\frac{2}{0}$; marine: leading to *Erycina*, and representing *Amphidesma.*

C. mutica. Sow. Man. f. 87.

Erycina† *Lam.* Shell always transverse, generally cuneate, but rarely equilateral; both valves closing; cardinal teeth $\frac{2}{0}$, between which is the ligament; lateral teeth $\frac{0}{2}$, one of which is lengthened.

striata. Sow. Gen. f. 2. plebeja. Ib. f. 3.
(*fig.* 118. *d, e.*)

* *Galathæa* of Lam.

† This name should be changed, having been previously applied by Fabricius to a large family of lepidopterous insects. *Eryx* may be used, as preserving the same mythological idea.

SUB-FAM. TELLININÆ.

Animal marine; the siphons excessively long. Shell rather thin, more or less compressed; bosses small.

PSAMMOBIA.* *Lam.* (*fig.* 118. *i.*) Shell transverse, oval or oblong, angulated, gapingatone or both ends; ligament external; cardinal teeth $\frac{2}{1}$.

rugosa *Sow.* Chem. 9. f. 79—82. ferroensis. Penn. 47. f. 31.
vespertina. Chem. 7. f. 59. Poli, i. pl. 15. f. 19.

TELLINA *Linn.* Shell transverse, greatly compressed, nearly equilateral; the valves on the inferior ligamental, or anterior side, sinuated and angulated; cardinal teeth $\frac{2}{2}$, or $\frac{2}{1}$; lateral teeth $\frac{2}{2}$, remote from the cardinal. (*fig.* 120. *a.*)

radiata. En. Méth. 289. f. 3. latirostra. Zool. Il. i. pl. 20.

LUCINA *Lam.* Shell generally round or orbicular, equilateral, the outer surface sculptured; ligament external; cardinal and lateral teeth distinct, but variable in their number; anterior muscular impression very long and narrow. (*fig.* 120. *c.*)

L. punctata. Sow. Gen. f. 1. Pennsylvanica. f. 4.

Ungulina † Lam. Shell irregularly orbicular; bosses central; cardinal teeth $\frac{1}{1}$, bifid; lateral teeth none; ligament both internal and external; impression of the mantle entire.

transversa *Lam.* Sow. Man. f. 88. (*fig.* 117. *d.*)

AMPHIDESMA *Lam.* Shell resembling *Lucina* in shape; the posterior side sometimes flexuose, and slightly gaping; cardinal teeth $\frac{1}{1}$ or $\frac{2}{2}$, with a cartilige between; ligament external.

A. variegata. En. Méth. 291. f. 3. lucinalis. Ib. 286. f.

LORIPES *Poli.* Shell orbicular, equilateral; cardinal teeth obsolete; lateral teeth none.

L. lactea. Poli, i. pl. 25. f. 28, 29.

* Representing the *Solens.*
† *Ungulina* Lam. seems to be merely an aberrant *Lucina.*

Sub-fam. VENERINÆ.

Animal with the two siphons shorter, and sometimes united; shell thick, strong, and ventricose; bosses prominent.

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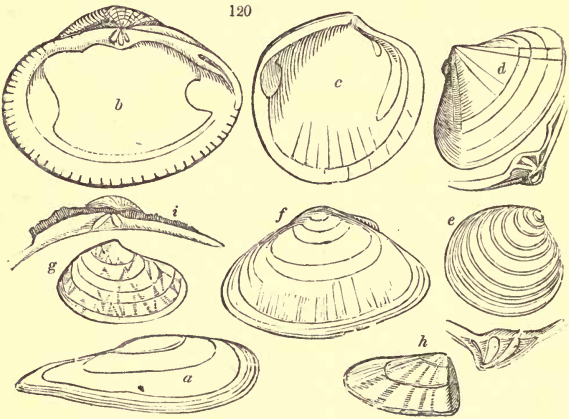


Corbis *Lam.* Shell transversely roundish; bosses curved in different directions; cardinal teeth $\frac{2}{1}$; lateral remote, short, $\frac{2}{2}$.

C. fimbriata. Sow. Gen. (*fig.* 120. *b, i.*)

Venus *Linn.* Animal with the two siphons shorter than its shell; shell nearly round, or oval; lateral teeth close to the cardinal teeth, $\frac{3}{3}$; lateral teeth approximate, and diverging from the summit of the bosses; surface often rough. (*fig.* 119. *c.*)

V. purpura. En. Méth. 278. f. 1. rugosa. Ib. 273. f. 4.

Crassina Lam.* Shell solid, suborbicular; bosses nearly central. Cardinal teeth $\frac{2}{2}$, unequal in one valve; lateral teeth none.

C. Danmoniensis. (*fig.* 120. *e.*)

* The other subgenera of *Tellina*, *Venus*, *Cytherea*, and *Donax*, are not worked out.

CYTHEREA *Lam.* Animal with the siphons entirely united; foot large, tongue-shaped; shell generally smooth and glossy; cardinal teeth $\frac{3}{3}$; lateral tooth $\frac{1}{1}$, placed on the anterior side. (*fig.* 120. *d, g.*)

C. Chione. Poli. ii. pl. 20. f. 1. maculata. En. Méth. 265. f. 4.

DONAX *Linn.* Shell cuneate, or wedge-shaped, the anterior side very short and truncate; teeth variable in the sub-genera. (*fig.* 120. *h.*)

D. scorotum. En. Méth. 260. f. 2.

CAPSA *Lam.* Shell transverse, nearly equilateral; cardinal teeth $\frac{2}{1}$; lateral teeth $\frac{2}{0}$; ligament external.

C. Braziliensis. Sow. Gen. f. 1. (*fig.* 120. *f.*)

CARDISSA *Sw.* Shell heart-shaped, excessively compressed; the anterior side truncate, and often concave; the posterior rounded.

spinosa *Sw.* En. Méth. 293. f. 3.

CARDIUM *Linn.* Shell ventricose, cordate, or longitudinally oval; umbones prominent; cardinal teeth $\frac{2}{2}$; lateral teeth $\frac{2}{2}$, remote.

Cardium Linn. Shell ventricose, equilateral; cordate, with costated ribs; often armed with spines. Typical.

costatum. Wood, General Conch. i. pl. 56. f. 1.
edula. Wood, Conch. pl. 55. f. 4.
tuberculatum, Sow. G. f. 3.

Lævicardium Sw. Shell longitudinally oval, inequilateral, the surface neither ribbed nor spired. Subtypical.

Europeum. Wood, Con. pl. 54. f. 1.
flavum. Wood, pl. 54. f. 2.
oblongum. Ib. 55. f. 1.
citrinum. Ib. 54. f. 3.
Æolicum. Ib. 57. f. 1.

Hemicardium Sw. Half heart-shaped; the anterior side abruptly truncated, and very short: representing *Donax*, &c.

H. unedo. Wood, Conch. pl. 58. f. 3.
fragrum. Wood, Conch. pl. 58. f. 1, 2.
retusum. Ib. 58. f. 4, 5.
lævum *Sw.* Ib. 57. f. 7, 8.

Acardo Sw. Hinge almost without teeth: representing the *Saxacavidæ*.

Card. edentulum. *Auct.*

Papyridea Sw. Shell heart-shaped, or transversely oval; inequilateral; the anterior side almost always gaping: representing the *Pholidæ*.

P. Soleniforme. Wood, Conch. pl. 56. f. 3.
transversum. Sow. Conch. f. 4.*
apertum. Ib. 56. f. 2.
ringens. Wood, pl. 53. f. 1, 2.

Family CHAMIDÆ.

Animal marine; shell often attached, irregular, not perlaceous, with or without short siphons; lateral teeth on the posterior side of the shell only; cardinal teeth variable.

Hippopus *Lam.* Cuneate; both valves closed; bosses nearly central; cardinal teeth small; lateral teeth long, posterior.

C. maculatus. Sow. Gen. f. 1. En. Méth. 236. f. 2.

Pleurorynchus Phillips. Anterior end abruptly truncate, as in *Hemicardium*; the hinge margin elongated into earlike processes. Fossil only.

elongatum. Sow. Min. Con. avicularis. Sow. Gen. f. 2.

Chama *Linn.* Shell irregular, attached by the lower valve; a single lengthened tooth in one valve, and a corresponding groove in the other.

C. Damæcornis. Sow. Gen. f. 1. arcinella. Sow. Gen. f. 2.

Isocardia Lam. Shell heart shaped, regular, ventricose; bosses remote, receding, turbinate; cardinal teeth lamellar.

I. cor. En. Méth. 232. f. 1.

Tridacna *Lam.* Animal affixed by a byssus, which passes through a large opening on the anterior side; cardinal teeth $\frac{1}{1}$.

gigas. En. Méth. 235. f. 1. elongata. Sow. Man. f. 57.

* This species, by uniting *Papyridea* and *Cardium*, completes the circular succession of the sub-generic types.

Cleidothærus Stuchbury. Shell resembling *Chama*, but somewhat pearly; hinge with an "internal, testaceous, curved appendage," inserted in a depression within each of the bosses.

C. chamoides. Sow. Man. f. 75.

Diceras Lam. Somewhat resembling *Isocardia*; but the bosses are excessively produced and turned different ways. Fossil only.

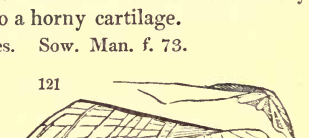
D. arietinum. Sow. Gen. f. 1.

Myochama * Stuchbury. Shell irregular, smooth, attached by the lower valve; umbones central; cardinal teeth small, $\frac{2}{}$, between which is an internal shelly appendage, attached to a horny cartilage.

M. anomiodes. Sow. Man. f. 73.

CARDITA † *Lam.* Shell free, cardiform, or sub-transverse, ribbed; cardinal teeth $\frac{1}{0}$ or $\frac{2}{1}$, lateral $\frac{1}{1}$; representing *Cardium*. (*fig.* 121.)

121



C. sulcatus. Sow. Gen. f. 3. imbricatus. Ib. f. 4.
calyculatus. Ib. f. 1, 2. oblonga. Ib.

FAMILY SAXICAVIDÆ.

Animal perforating; shell often irregular; lateral teeth none; cardinal teeth variable or obsolete.

SAXICAVA *Lam.* Shell transversely oval, irregular, gaping at one or both ends; ligament external; teeth obsolete. (*fig.* 122. *a*, *e*.)

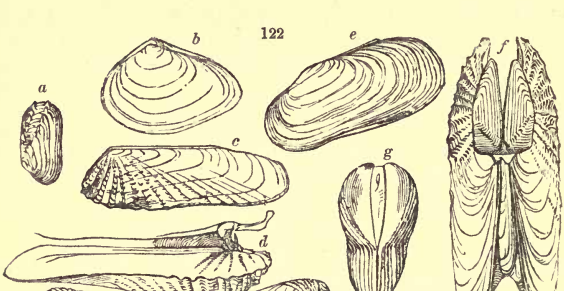
S. rugosa. Sow. Gen. f. 1—4.

Petricola Lam. Shell transversely oval or oblong; the valves gaping; cardinal teeth variable, but always present; lateral teeth none (*fig.* 122. *b*, *c*, *d*.)

P. dactylus. Sow. Gen. f. 3. ochroleuca. Ib. f. 4. (*b*.)

* Affinities uncertain.

† Including *Venericardia* and *Cypricardia* Lam. (*fig.* 121.), the latter seems an aberrant *Cardita*, passing into *Coralliophaga*.



Coralliophaga Blainv. Transversely cylindrical; the bosses placed close to the anterior margin; cardinal teeth $\frac{2}{2}$, one being bifid; lateral teeth obsolete. A doubtful type, but connected to *Cardita*.

C. carditoidea. Sow. Man. f. 92.

Thracia Leach.* Shell transversely oval, posterior side truncate; bosses central; lateral hinge margin thickened; ligament external; no teeth?; affinities and rank uncertain.

T. corbuloidea. Sow. Man. f. 93.

Galeomma *Turton.*† Thin, oval, equilateral; the ventral margin considerably gaping; cardinal teeth $\frac{1}{1}$; ligament internal and external.

G. Turtoni. Sow. Gen. f 1—3. Mauritiana. Ib. f. 4, 5.

Venerupes ‡ *Lam.* Animal perforating, analogous to that of the *Solens*; shell transverse; the anterior side

* I have not seen this shell; the figure, but not the definition, being in Sowerby's *Manual*. *Sphœnia*, Turton, seems to be an aberrant species of *Saxicava*, with the thickened hinge margin of *Thracia*.

† Passes into *Gastrochœna*, and thus completes the circle of this tribe.

‡ Judiciously contracted from *Venerirupes*. These perforating animals have no connection whatever with *Pullastra*. See Poli, vol. ii.

very short, the posterior gaping; cardinal teeth $\frac{2}{3}$ or $\frac{1}{3}$, small and nearly parallel; ligament external.

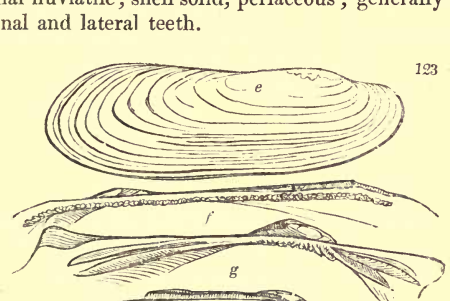
V. irus. Poli, i. pl. 10. f. 1, 2.; and ii. pl. 19. f. 25, 26.

Tribe 3. ATRACHIA.

Animal without siphons.

Family 1. UNIONIDÆ. *River Muscles*, or *Unios*.

Animal fluviatile; shell solid, perlaceous; generally with cardinal and lateral teeth.



Sub-fam. 1. UNIONINÆ.

One valve, with two cardinal and two lateral teeth; cardinal teeth short; the umbones, or bosses, smooth or longitudinally undulated.

Unio *Lam.* Cardinal teeth short, oblique, receding from the anterior margin of the shell. (*fig.* 123. *h.*)

Unio. Oval or round, but never winged; bosses very prominent; cardinal teeth very thick.

U. Mytiloides *Rafinesque.*
circula. Lea. Am. Tr. iii. pl. 9. 14.
torsa *Rafinesque.*
sulcata. Lea. Am. Tr. iii. pl. 8. f. 12.
cornuta *Barnes.*

Cunicula Sw. Ovate oblong; bosses thick, but depressed; cardinal teeth moderate.

C. planulata. Lea. Am. Tr. iii. pl. 9. f. 13.
patula. Ib. p. f. 20.
rubiginosa. Ib. pl. 8. f. 10.
secura. Ib. pl. 2. f. 17.
purpurascens. Lam. vi. 1. p. 73.

Ligumia Sw. Very long and pod-shaped; bosses depressed; cardinal teeth moderate.

S. recta. Lam. vi. 1. p. 74.

Theliderma Sw. Posterior hinge margin elevated and winged; surface of the valves tuberculated; cardinal and lateral teeth perfect.

T. metanerva *Raf.*
lachrymosa *Lea.*
pustulosa *Lea.*
irrorata *Lea.*
nodulosa *Wood.* Gen. Conch.
verrucosa *Barnes.*
Peruviana *Lam.* En. Méth. 248. f. 7.

Megadomus Sw. Only one lateral tooth in each valve; cardinal teeth two; posterior hinge margin winged.

M. gigas *Sw.*

Æglia *Sw.* Shell generally cuneate; bosses moderate; cardinal teeth short, compressed, diverging towards the anterior margin.

Æglia Sw. Shell cuneate; bosses prominent; cardinal teeth much compressed, placed on one side of the bosses.

Æ. ovata *Say.* Occidens *Lea.* Am. Tr. iii. pl. 10.

Naidea Sw. Shell ovate; bosses depressed; cardinal teeth short, thick, obtuse, placed immediately beneath the bosses.

N. ater *Lea.* Am. Tr. iii. pl. 7.

Canthyria Sw. Shell ovate; cardinal teeth long, compressed; surface of the shell spinous.

C. spinosa (*U. spinosa* Lea). Syn. frontisp.

Mysca *Turton.* Shell elongated, oblong-ovate; car-

dinal teeth compressed and crenated; the outer sharp, and almost parallel with the anterior margin.

M. pictorum* *Linn.* En. Méth. 248. f. 4.
ovata *Sw.* (*fig.* 56.)
Batava *Lam.* En. Méth. 248. f. 3.
marginalis. Ib. 247. f. 1.

Potomida Sw. Oval; cardinal teeth short, thick, the outer one diverging towards the anterior margin.

P. sinuata *Lam.* En. Méth. pl. 248. f. *a*, *b*.
corrugata *Sw.* (*fig.* 51.)
littoralis. En. M. 248. f. 2.

Lymnadea Sw. Posterior hinge margin elevated and winged; the valves connate; the surface smooth.

L. alata *Sw.* Ex. Conch. (*fig.* 48.)
fragilis *Sw.* Zool. Ill.
? compressa *Lea.* Am. Tr. iii. pl. 12. f. 22.

Sub-fam. 2. HYRIANÆ.

Bosses longitudinally sulcated; cardinal teeth long, compressed, placed on one side of the bosses; hinge margin winged. (*fig.* 123. *g*.)

Iridea *Sw.* Oblong ovate; bosses small, depressed, sulcated; inner cardinal tooth placed beneath the outer.

I. granosa *Lam.* En. Méth. 248. f. 9.†

Castalia *Lam.* Oval or trigonal, nearly equilateral; bosses prominent; cardinal teeth short, thick; the outer largest and crested.

Naïa Sw. Oval; cardinal teeth beneath the bosses, and deeply sulcated.

C. corrugata *Lam.* En. Méth. 248. f. 8.
picta *Sw.* En. Méth. 248. f. 6.

Castalia Lam. Trigonal, nearly heart-shaped.

C. cordata‡ *Sw.* Sow. Man. f. 140.
pectinata *Spix.* Braz. Test. pl. 25. f. 3, 4.

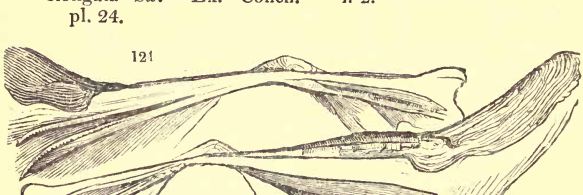
* And of all the British writers who have not confounded it with the British *Orata*, as Lamarck has done.

† This is not a typical species, but it is the only one, out of ten or twelve, which I believe is figured.

‡ *Castalia ambigua* Lam. A name quite inadmissible to a decided species; it is the *Cordata* of Humphrey.

HYRIA *Lam.* Hinge margin straight; both extremities elevated and winged; cardinal teeth very long, and resembling lateral teeth. (*fig.* 124.)

syrmatophora *Gmelin*, 3222. corrugata. En. Méth. pl. 247.
elongata *Sw.* Ex. Conch. f. 2. pl. 24.



HYRIDELLA Sw. Transversely oval; bosses not sulcated; posterior margin elevated and winged; one cardinal and one lateral tooth in each valve.

H. australis. Lam. Sys. vi. 1. p. 80.

SUB-FAM. 3. IRIDININÆ.

Narrow and greatly elongated; hinge margin without teeth, but sometimes granulated. (*fig.* 123. *e, f.*)

IRIDINA Lam. Hinge margin granulated.

I. striata *Sw.* Monog. En. Méth. 204. bis 1.*
ovata *Sw.* Monog.
elongata *Sow.* (private plate).

CALLISCAPHA Sw. Hinge margin smooth.

C. Nilotica *Sow.* Zool. Journ. i. pl. 2.

MYCETOPUS *D'Orb.* Pod-shaped; hinge margin straight, smooth; the extremities obtusely rounded, or subtruncated; considerably gaping; animal perforating (?)

Solenoides. Sow. Man. f. 151.

* The figure represents this as an "arcuate" shell, very different from that figured by the late Mr. Sowerby.

Sub-fam. 4. ANODONTINÆ.

Cardinal teeth none; lateral tooth extending along the hinge or entirely wanting; hinge margin generally winged.

Lamproscapha Sw. Shell not winged, elongate pod-shaped; teeth none; bosses near the anterior extremity. Tropical America only?

L.? elongata *Sw.* Zool. Ill. i. 176.
ensiforme *Spix.* Braz. Test.
siliquosa. Braz. Test.
pygmea. Ib.

*Symphynota** Lea. A single or double lamellar tooth extending the whole length of the hinge margin; valves generally winged and connate. (*fig.* 123. *i.*)

plicata *Leach.* Zool. Miss.†
lavissima *Lea.* Am. Tr. iii. pl. 13. f. 23.
bialata *Lea.* Ib. pl. 14. f. 24.
? tenuissima. Am. Tr. iii. pl. 11. f. 21.‡
rubens. En. Méth. 201. f. 1.

Anodon Lam. Doubly winged; no lamellar or other teeth.

A. cataracta *Lam.* vi. 1. p. 85.
cygnea *Lam.* Gualt. pl. 7. f. F.

Hemiodon Sw. Shell ovate; tubercles or undulations on the hinge margin, representing cardinal teeth.

H. undulatus. (*An. rugosus* Zool. Ill. i. 96.)
purpurascens Zool. Ill. i. 160.
areolata. Id. ii. 18.

Patularia Sw. Shell nearly equilateral, round or cordate; no teeth.

T. ovata *Sw.* Ex. Conch. pl. 36.
rotundatus, Ib. pl. 137.

Sub-fam. 5. ALASMODONTINÆ.

Lateral teeth entirely wanting; cardinal teeth one or two.

* *Dipsus* Leach.

† Differs from *bialata* by having oblique depressions towards the bosses or beaks, which latter also are *not* marked with "concentric undulations."

‡ Seems to form the passage to *Anodon*. Specimens labelled by Mr. Lea, were totally different from my *Hem. purpurascens.*

Calceola Sw.* Shell ovate; posterior hinge margin angulated; one cardinal tooth, and generally a small single lateral tooth in each valve.

C. angulata *Sw.* Am. Tr. 1827, pl. 3. f. 1.

Alasmodon *Say.* Trigonal; nearly equilateral; bosses large, prominent; two cardinal teeth.

A. undulata *Say.*

Uniopsis Sw. Oval; bosses prominent; cardinal teeth two, irregular, receding from the anterior margin.

U. Mytiloïdes. (*fig.* 62.)†

Margaritana Schum. Elongated, and somewhat arcuated; bosses small; posterior hinge plate long, convex, sometimes with the rudiments of a tooth; cardinal teeth two or one, small, obtuse.

M. elongata *Lam.*‡ arcuata *Barnes.*

Complanaria Sw. Shell winged; the valves connate; the bosses very small and depressed; cardinal teeth two or three; lateral teeth represented by irregular grooves.

gigas *Sw.* Sow. Gen. f. 141. rugosa *Sw.* (*Al. rugosa*) Barnes.

Family 2. ARCADÆ. *Arch-Shells.*

Marine; hinge margin furnished with numerous small well-defined teeth, without any distinction of cardinal and lateral; umbones generally remote, mostly covered with an epidermis.

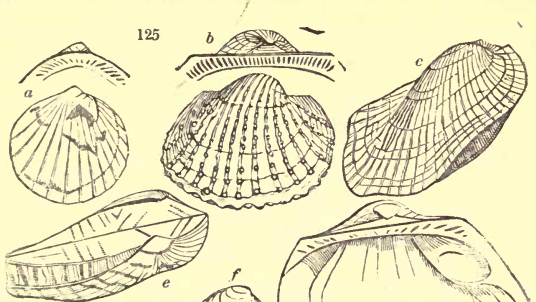
Nucula *Lam.* Perlaceous; shape various; beneath the umbones, a spatulate enlargement or pit containing the cartilage; teeth small, numerous, prominent, and pectinate: marine and fluviatile. (*fig.* 125. *f, g.*)

margaritacea. Sow. Gen. f. 7.

* The situation of this type seems doubtful, but as I have more than one species of the same form, but without the small lateral tooth, I conjecture they all stand between *Alasmodon* and *Anodon.*

† See note at p. 289.

‡ This is the true *Mya margaritifera* of British authors, for which Lamarck only quotes the figures of Pennant and Da Costa; and as he was the first to distinguish it as different from the other European species, I think his specific name has every right of priority.



PECTUNCULUS *Lam.* Orbicular; the bosses central; hinge margin curved, with a line of small oblique teeth diverging on each side. (*fig.* 125. *a.*)

P. pilosus. Sow. Man. f. 134.

ARCA. Shell of various shapes, either equivalve or inequivalve, but the valves closing all round; the bosses very prominent; hinge margin always straight; the teeth small.* (*fig.* 125. *b, d.*)

A. antiquata. Sow. Man. f. 131.

BYSSOARCA † *Sw.* Shell always transversely oblong or oval, generally angulated; hinge margin straight, often auriculated; the teeth minute; valves gaping on the basal margin. (*fig.* 125. *c, e.*)

B. Zebra. Zool. Ill. ii. pl. 113. Noæ. Sow. Gen. f. 132.

TRIGONIA *Lam.* Shell perlaceous, sub-cardiform, one extremity rounded, the other truncated and compressed; cardinal teeth $\frac{2}{4}$, sagittate, compressed, and regularly grooved: intermediate between *Byssoarca* and *Nucula*, and representing *Cardium*, *Pandora*, and all the other cardiform types.

T. pectinata. Sow. Gen. Man. f. 139.

* The sub-genera require to be made out: one of these is *Cucullæa*.
† The above remark is also applicable to this group.

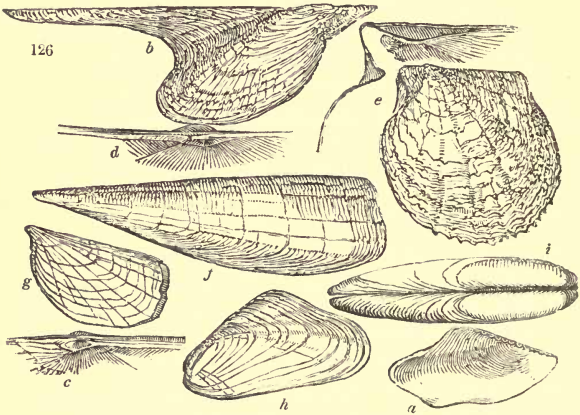
FAMILY 3. AVICULIDÆ. *Muscles and Pearl Oysters.*

Animal attached, byssiferous; shells lamellar, internally perlaceous; the valves generally gaping. (*fig.* 126.)

MYTILUS *Linn.* Oblong, transverse; the bosses small, close to the anterior margin; both extremities rounded; hinge margin straight, and generally forming an angle; valves not always gaping; teeth (except in *Brachidontes*) none.

Brachidontes Sw. Umbones prominent, not terminal; valves corrugated; hinge margin considerably angulated; teeth many, small, and crenate.

sulcata. En. Méth. 220. f. 2.



Modiola Lam. Resembling the last, but the hinge without teeth, and the shell smooth; valves slightly gaping. (*fig.* 126. *h.*)

M. tulipa. Sow. Gen. f. 160.

Lithodomus Cuv. Animal perforating; shell oblong, ventricose, nearly cylindrical; the hinge margin not

elevated; umbones terminal; the posterior end sometimes rostrated. (*fig.* 126. *i.*)

L. dactylus. Sow. Man. f. 161.

Mytilus Linn. Shell transverse, somewhat triangular, from the straightness and elevation of the hinge margin; umbones minute, terminal, sometimes with an obsolete tooth.

M. achatinus. Sow. Man. f. 158.

Lanistes Humph. Shell oval, transversely cardiform, ventricose; umbones prominent, with diverging elevated striæ; hinge margin not elevated or angulated; teeth none: the cardiform type.

discors. En. Méth. 204. f. 5.

PERNA. Shells sometimes irregular, inequivalve, oyster-shaped, greatly compressed; the margins brittle; hinge plate broad, with numerous teeth, separated by parallel grooves containing the ligament, and gaping near the umbones.

Gervillia Def. General form of *Modiola;* hinge long, straight, with small, irregular, transverse grooves. Fossil only.

G. avicularis. Sow. Man. f. 169.

Crenatula Lam. Irregularly oval, compressed; hinge margin straight, with a few semicircular excavations, containing the ligament; umbones terminal. (*fig.* 126. *a.*)

C. Mytiloïdes. Sow. Man. f. 168.

Perna Lam. Shape various; valves always equally flattened; but the hinge margin always straight, not prolonged; the plate marked with numerous transverse regular grooves.

P. Ephippium. Sow. Gen. f. 166.

Pulvinites Def. Valves unequal,—one being flat, the other convex; hinge short, grooved, as in the last: representing *Corbula*, &c.

P. Adansoni. Sow. Man. f. 170.

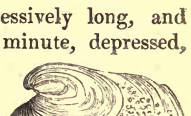
Inoceramus Sow. Cardiform, thick; umbones lateral, rather prominent, and incurved; hinge short, formed of a series of short transverse grooves: the cardiform type.

I. Lamarckii. Sow. Man. f. 167.

Malleus. Shell very irregular, more or less hammer-shaped; the hinge margin being straight, and often greater prolonged; the valves gaping to near the umbones.

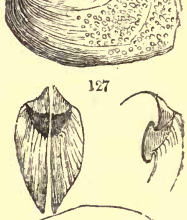
Malleus Lam. Hinge margin excessively long, and forming two auricles; umbones minute, depressed, with a small disk for the ligament, and an external groove for the cartilage.

M. vulgaris. Sow. Man. 167.



Reniella Sw. Shell transversely and irregularly orbicular; subventricose near the umbones, which are very small, terminal, and remote; between them is a deep triangular concave pit, lined by the ligament; the margin of this pit forms a semicircle, to the edge of which is attached a narrow cartilage.

R. dilatata *Sw.* (*fig.* 127.)



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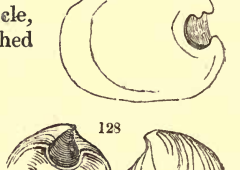
Vulsella *Lam.* Shell tongue-shaped, longitudinally elongated, compressed, without auricles; umbones minute, curved, approximating; hinge plate thick, diluted into a semicircular solid pit for the cartilage.



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V. lingulata. Sow. Man. f. 185. (*fig.* 128.)

Avicula. Shell regular, foliaceous, unequally auriculated; hinge margin straight, much lengthened;

umbones lateral or sublateral; byssus protruded near the umbones.

Margarita Leach. (1817.) Shell more or less rounded; auricles small; umbones sub-lateral; the hinge margin straight, but not lengthened; teeth small, tuberculated, nearly obsolete. (*fig.* 126. *e.*)

crocata. Zool. Ill. ii. pl. 55.

Avicula Lam. Shell obliquely oval; the hinge margin very much lengthened, and forming unequal auricles; teeth tuberculous, nearly or quite obsolete. (*fig.* 121. *b, c, d.*)

A. heteroptera. Sow. Gen. f. 1. aculeata. Ib. f. 2.

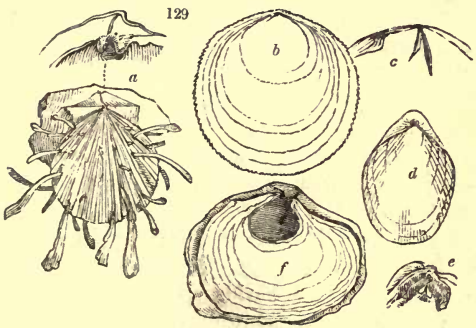
PINNA. Shell equivalve, wedge-shaped or triangular; umbones terminal; the other extremity widely gaping; hinge margin straight; teeth none; anterior margin slightly gaping.* (*fig.* 126. *f, g.*)

P. serrata. Sow. Gen.

FAMILY 4. OSTRACIDÆ. *Oysters.*

Animal sedentary, generally affixed by their under valve; shell foliaceous, rarely pearly. (*fig.* 129.)

PECTEN *Linn.* Shell regular, depressed, nearly orbicular, auriculated; umbones central; ligament small; internal hinge margin short; teeth straight.



* This genus, by coming close to *Mytilus* completes the circle of this family.

Lima Linn. Longitudinally oval; valves gaping on one side near the umbones; animal similar to avicula, connecting this family with the last.

L. squamosa. Sow. Man. 174.

Pecten Brug. Shell generally free, sometimes slightly attached by a byssus; orbicular or ovate; auricles nearly equal; umbones central; valves closing all round; hinge margin straight; no teeth; ligament triangular, internal.

Decadopecten Rüppell. General form of *Pecten*, but with plicated teeth of the hinge: analogous to *Nucula*.

D. plicata Sow. Man. f. 172.

Pleuronectia Sw. General form of *Pecten*, but the valves very much compressed and gaping at their edges.

P. lævigata *Sw.* En. Méth. 208. f. 3.

Hinnites Def. Animal attached; shell pectiniform, but irregular.

H. pusio. Sow. Man. f. 173.

Spondylus. Shell inequivalve, attached by its under valve; rough, with spines and plates; umbones central, remote, separated by a triangular disk.

Plagiostoma Sow. Shell free, inequilateral, oblique; umbones remote; sub-auriculated on one side; hinge straight in one valve, with a triangular notch in the other; surface spinous or smooth. Fossil only.

P. spinosum. Sow. Man. f. 176.

Spondylus Lam. Shell attached; spinous and foliaceous externally; auriculated hinge, with two teeth locking into cavities (*fig.* 129. *a.*)

S. Americanus. Sow. Man. f. 177.

Dianchora Sow. Shell attached, obliquely pectiniform, the attached valve having an opening at the boss, the other auriculated with an obtuse boss; teeth none: passing into *Ostrea* by *Pedum*.

D. striata. Sow. Man. f. 175.

OSTREA *Linn.* Shell foliaceous, irregular, generally attached by the under valve; hinge usually without teeth.

Pedum Brug. Shell hatchet-shaped, depressed; inequivalve, slightly auriculate; umbones small, remote; sides of the lower valve turned upwards, with a deep sinus for the passage of the substance by which it adheres; a small, central, spatulate tooth in each valve bears the cartilage, and a transverse central furrow between the umbones holds the ligament, which spreads also between the umbones.

P. spondyloideum. Sow. Gen. f. 1—5.

Dendrostræa Sw. Shell irregular, equivalve, attached by its lower valve by extraneous processes; the margins solid and plicated.

D. folium. Sow. Gen. f. 3. crista-galli. Sow. Gen. f. 2. carinata. Ib. f. 1.

Ostræa Linn. Shell irregular, round or oval, inequivalve; the margins thin and brittle; no teeth; umbones central.

O. edulis. Sow. Gen. f. 2. cingulata. Ib. f. 1.
Virginica. Ib. f. 1.

Gryphæa Lam. Shell regular, inequivalve; one valve convex, with the umbo recurved, the other smaller, and nearly flat; margin of the valves not foliaceous.

G. incurva (*fig.* 130.) Sow. Gen. f. 2. dilatata. Ib. f. 3.

Plicatula Lam. Shell irregularly ovate, plicated, inequivalve; one valve more convex than the other; cardinal teeth $\frac{2}{2}$ sagittate; the sides strongly, regularly, and transversely grooved; between the teeth is the internal ligament. (*fig.* 129. *e.*)

P. gibbosa. Sow. Gen. f. 1, 2.

ANOMIA *Linn.* Shell thin, perlaceous, very irregular, inequivalve; attached by a calcareous mass, which

passes through an opening near the umbo of the lower or smaller valve, which is flat; the other is convex. (*fig.* 129. *f.*)

A. Ephippium. Sow. Man. f. 186.

PLACUNA *Brug.* Shell very much compressed, perlaceous, with two internal lamellar, sagittate, cardinal teeth in one valve. (*fig.* 129. *b, c.*)

*Placunomia.** Shell attached, with the form and general structure of *Anomia*, but with two sagittate cardinal teeth.

Cumingii. Sow. Man. f. 189.

Placuna Brug. Shell not attached, foliaceous, roundish; the valves equally flattened: united to *Pecten* by *Pleuronecta.*

P. placenta. En. Méth. 173. f. 2.

FAMILY 5. ETHERIDÆ. *River Oysters.*

Irregular, inequivalve, foliaceous; pearly within; epidermis olive green; ligament partly internal and partly external.

ETHERIA *Lam.* Muscular impressions two; shell irregular; teeth none.

E. semilunata. Sow. Man. f. 155.

MULLERIA *De Fer.* Muscular impression single; shell sub-quadrate; hinge irregular; teeth none.

M. lobata. Sow. Man. f. 192.

Abridged from *Placunanomia* Sow.

EXPLANATION OF TERMS

USED IN DESCRIBING THE SHELLS OF TESTACEOUS MOLLUSCA.

Accessary Valves. Small additional valves placed near the umbones or bosses of the genus *Pholas* among shells, and on the edges of the pedunculated barnacles, among annulose animals.

Acephalous. Mollusca without an apparent head, comprehending the bivalves of conchologists.

Acuminated. Ending in a graduated and often acute point.

Adductor muscle. That which closes the two pieces of a bivalve together, the base or insertion of which is indicated by an irregular depression in each valve, these being called the muscular impressions.

Anterior, when applied to the sizes of bivalve shells, is that in which the ligament is not placed.

Apex. The point or nucleus of a shell; hence the bosses of bivalves, the points or top of limpets, or of univalve shells, are so called.

Aperture, or mouth of univalve shells, is the cavity from which the head of the animal is protruded.

Arcuated. Curved or arched.

Auriculated, or eared. A term given to a few bivalves which have a flat angulated projection on one or both sides of the umbones, or bosses: these processes are most developed in the *Pectens,* and are merely

an incipient modification of the angular dilation of the hinge margin in *Byssoarca*, and several other genera.

Auriform, or ear-shaped, as in *Haliotis*.

Base. This term in regard to shells is variously applied: generally speaking, it is used in opposition to the apex or end of univalve shells, although, correctly speaking, it is at this part where the head of the animal protrudes. In such bivalves as adhere to other substances by one of their valves, as in *Spondylus*, *Anomia*, &c. that valve is termed the *basal*. In unattached bivalves the term cannot be properly employed. In reference to the whorls of spiral shells, the last or largest is termed the basal whorl.

Bivalve. Shells of the order *Dithyra*, having two valves.

Bifid. Cleft, or double.

Byssus. A bunch of silk-like fibres, by which many bivalves adhere to other substances, without the shell itself being deprived of motion. The *Pinnæ*, or wing-shells, are the most typical examples; but many other genera, as the Pearl and Hammer oysters and even some of the muscles are thus provided. When dried, the byssus of the large Neapolitan *Pinna* is sometimes fabricated into gloves, but only as objects of curiosity, since, as we know by personal inquiry, it is a most tedious and difficult process.

Callous. When there is a thickening of enamel upon any particular part of a shell, resembling a tumour, it is termed callous, or a callosity: this is observed among spiral shells, in the inner lip of the Olives, Naticæ, and many others, and is very common near the hinge of certain bivalves.

Canal. A groove or gutter observable in different parts of certain spiral shells, belonging to the *Zoophaga*, or carnivorous tribe. In these the canal is either lengthened, as in *Murex*, short as in *Harpa*,

or truncate as in *Buccinum*; in the two latter it thus gives place to a notch, but in all these instances it is that part fitted for the protrusion of the long cylindrical siphon possessed by all these animals. This part, also, constitutes the base of the shell. Besides this, there is in many of the mitres, *Strombi*, and other predaceous genera, another channel or groove, placed in the interior of the *upper* part of the aperture, the use of which has not been fully ascertained.

Cancellated. When the surface is marked by striæ or lines, which cross each other at right angles.

Cardinal teeth of bivalves, are those placed immediately beneath the bosses, and between the lateral teeth where such exist, as in the common cockle.

Carinated, or keeled. Furnished with an elevated, and often a sharp ridge, either on the surface or margin of the shell.

Chambered. Divided internally into compartments, as in the testaceous *Cephalopoda,* or Nautilus.

Clavate, club-shaped. One extremity being slender and pointed, the other thick and obtuse. Many of the zoophagous genera, as *Cerithium,* &c. are peculiarly strong examples.

Columella, or Pillar. The internal support of most spiral shells, round which the whorls convolute: it is not present in *Solarium, Delphinula,* the typical *Scalaria,* and a few other genera; all of which, in consequence, have the umbilicus so deep. that it extends to the apex or top of the shell. The basal portion of the columella generally forms the support of the inner lip, and always that around which the plaits are disposed, as in the Volutes; it is sometimes greatly thickened, as in *Ancillaria,* and all the Olives.

Concentric. Stripes, grooves, or other external marks indicating the progressive enlargement or growth of the shell: hence those indented stripes or striæ in

bivalves, which run parallel to the margin, are termed concentric. Among spiral shells these indications are less common, but the Wentletrap is a good example.

Corneous. Resembling the colour or substance of horn: the epidermis of some, and the operculum of other spiral shells, often present this appearance.

Coronated, or crowned. Spiral shells which have their whorls more or less surmounted by a row of spines, or tubercles, are termed coronated. The typical *Volutes,* or melon shells, several cones, mitres, &c. are thus ornamented.

Crenated. Small indentations, generally sharp and regular, often placed on the outer lip of spiral shells, particularly on many of the typical mitres, as *M. papalis, episcopalis,* &c. *Harpa crenata* is also a good example: in bivalves fewer examples occur, and these only in the teeth, as *Byssoarca* and *Iridina.*

Cuniform. Wedge-shaped, as *Donax:* this shape, comng bivalves, is analogous to that of clavate univalves.

Deciduous. Any part which falls off in a more advanced stage of growth, as the terminal whorls of the pupaform land-shells, to which, indeed, this peculiarity is almost confined.

Dextral. When the mouth or aperture of a spiral shell is on the right hand; when on the left, it is sinistral or reversed. The great majority of spiral shells are dextral, but frequently in the very same species (as in *Bulimus*), individuals occur whose aperture is reversed. This, by the way, shows the insufficiency of making such deviations the ground of generic distinctions. In some genera, on the other hand, as *Physa,* all the species are reversed.

Digitated. The expansion of any particular part, as in the outer lip of the scorpion *Strombi,* into finger-shaped processes.

Discoid, or discoidal. Circular or disk-shaped, and much flattened. The freshwater genus *Planorbis,* and

many of the *Helicidæ*, or land-shells, are of this form.

Dorsal. All shells are dorsal, because they are all placed upon the back of the animal: the term, therefore, is only applicable to the valves of bivalves, and merely serves to distinguish that part of their circumference on which the bosses are placed, in opposition to that which, when the animal is crawling, is nearest the belly. The upper part of a spiral shell, when the mouth is downward, may be termed its back, or dorsal surface.

Emarginate. A small notch, or fissure, wherever it may occur: thus the base of most predacous *Testacea*, not provided with a canal, are emarginate; so also is one extremity of *Parmophorus*, although in a very slight degree, while, in the genus *Emarginula*, the notch becomes a deep slit.

Epidermis. A name generally applied to the outer rough coating of shells, over which it spreads as a fibrous horny skin, although not really such, being destitute of sensation.

Entire. Immarginate, or uninterrupted, in opposition to emarginate.

Equilateral. When both sides of a bivalve are equal, the umbones or bosses being nearly, or quite, in the middle: this is nearly the case with the common cockle.

Equivalve. The two valves of equal size and depth, as in the generality of bivalves.

Fibrous. Resembling fibres; applied to the substance of a shell it indicates those, like the *Pinna*, whose fracture presents perpendicular fibres.

Fimbriated. Thin elevated processes, somewhat resembling fins, possessed by many of the *Murices*, as *Murex fimbriata*, &c., and sometimes placed round the aperture of cyclostomous land shells.

Foliated. Resembling leaves. As used for the external surface of shells, the varices, or spines, on many of the *Murices* are foliated, or divided at their margins into leaf-like segments, as in the rosebush *Murex;* but applied to the substance, it indicates those bivalves which are composed of thin flat plates, very fragile, and lying upon each other, as in the common and pearl oysters. Sometimes the spines of bivalves are partly foliated, as in the genus *Spondylus.*

Front. The front of a shell is obviously that near to which the head of the animal protrudes: but this term, however objectionable, is given to the under surface of spiral shells, or that where the aperture is placed, in contra-distinction to the back.

Fusiform, or spindle-shaped; thickest in the middle, and attenuated or tapering to the extremities. *Fusus, Fasciolaria,* and many mitres, are more or less of this form.

Gaping. A bivalve is called gaping, when any part of the margins do not touch.

Gibbous, or humped. Any part of a shell more particularly elevated above the surface, or unusually so in comparison to other species, is termed gibbous, as *Strombus gibbosus.*

Granulated, or grained. Marked by elevated, close set, and regular dots, resembling grains: this appearance is very common at the base of the predaceous spiral genera.

Hinge margin in bivalves, see *Dorsal* margin. The hinge is composed of the ligament, the cartilage, and the teeth.

Hyaline. Of a glassy, thin, and semi-transparent substance.

Imbricated. Plates or folds laid over each other, like tiles on the roof of a house.

Incrassated. Any part more thickened than usual, or than the surrounding surface. The inner lip of *Oliva* and the hinge of *Glycimeris* are good examples among the spiral and acephalous tribes.

Incurved. The point turned inwards.

Indented. A term of very comprehensive meaning: it is used, generally, to express any thing depressed or sunk beneath the surrounding surface, whether they are lines, dots, irregular cavities, or tooth-like depressions. Many shells are marked by indented striæ. The suture of others is also indented.

Inequivalve. One valve smaller than the other, as in *Anomia* and *Terebratula.*

Inferior valve of adherent bivalves, is that by which the shell is united to other substances.

Inflated. See *Ventricose.*

Irregular bivalves. Such as, from being influenced in their growth by the substances in which they reside, do not present a uniformity of shape in the individuals of the same species. This variation is almost confined to the perforating groups; among which, however, as in *Lithodomus,* this deviation from a uniform specific shape is not found.

Lamellated. Shells whose substance is composed of very thin plates or lamellæ, which do not present a solid surface, as in the pearl oysters.

Lateral. Any thing on the sides of a shell. Thus the lateral teeth of bivalves, where they exist, are on one or both sides of the cardinal teeth, which are always central.

Length of shells. Spiral shells are measured from the tip of the spire to the base, and therefore perpendicularly: but the length of bivalves is taken horizontally; thus the *Soleus* are the longest shells of this tribe, the length being taken from the anterior to the posterior margin.

Ligament. An exteranl substance, by which the two valves of acephalous *Testacea* are united, and which, in fact, is the true hinge. The internal part is generally composed of another substance, called the cartilage, of a compact fibrous structure, which is elastic when moistened, but very hard and solid when dry. This is generally placed close to the bosses, and is often continued between the teeth, so as to form a second or internal ligament.

Lips. The two sides of the aperture of spiral shells are termed the lips. That which joins, and generally folds over, the lower part of the columella, is called the *inner* lip, while that part of the circumference opposite is the *outer*. The latter, of course, is found in all shells, because it is the termination of the last whorl; but the inner lip is frequently absent, or only indicated by a thin, whitish, almost transparent enamel: sometimes, however, it is highly developed, as in *Nassa*, the typical *Cassides*, or helmet-shells, and several others.

Lobed. A broad obtuse division, as in many of the *Strombi* and *Pleurotominæ*.

Longitudinal. The meaning of this term, as used and understood by all the best conchologists, is "lengthwise;" hence it means any stripes which run in a perpendicular direction from the apex to the base of spiral shells, while such as are in a contrary direction—that is, parallel to the suture of the whorls, are transverse. Great confusion, therefore, is likely to be introduced by reversing these definitions.* However objectionable they may be thought by fastidious persons, we always have and shall continue to designate the direction of stripes, bands, or other peculiarities, as *longitudinal* when they run in the direction of the *length* of a spiral shell, and *transverse* when they cross its breadth. The latter term, however, is not applicable to bivalves, because such marks

* As is done in the *Conchological Manual*.

always spring from the bosses, and, widening as they approach the ventral margin, become *radiated.*

Lunate, or lunulate, assuming the form of a crescent or half-moon. The aperture of the nerits is of this description, as well as the muscular impressions of most bivalves.

Mamillary, or mamillated. Smooth, thick, and obtuse, like a teat. The apex of the typical volutes, as *Voluta olla, Diadema* &c. are strictly of this description, as also those of *Harpula fulgetrum, Scaphella papillosa,* and other volutes: but *C. vespertilio* is not so, for the spire is distinctly plaited, and even rough with obsolete spines.

Measurement, see *Length.*

Multivalve. The only multivalve *Testacea,* properly so called, are the chitons and the perforating genera belonging or closely allied to *Teredo* and *Pholas.* The *Cirripedes* are annulose animals or insects, and have no place whatever among the molluscous tribes, any more than beetles or butterflies.

Muscular Impressions: those indented marks in acephalous bivalves, indicating the insertion of those muscles by which the animal is attached to its shell. Of these there are three principal sorts,—lateral, central, and pallial. 1. The lateral impressions indicate the animal to have two adductor muscles, as in *Unio Cardium,* and all the most typical bivalves. 2. A central impression shows us the presence of but one adductor muscle, which is generally in the middle of the shell, as in the common oyster. All these shells, however, are furnished with the third or pallial muscle, which is indicated by a depressed line, often sinuated, running parallel with the ventral margin.

Obsolete. This term, in conchology, is more properly restricted to implying a faint indication of particular characters. Thus, very slight and partially

indistinct *striæ* upon a shell are called obsolete *striæ*, not because they are worn off by accident, but because they are only rudimentary, or very slightly developed.

Operculum. The hard lid, either corneous or calcareous, which closes the mouth of many spiral shells, and is carried on the posterior part of the belly of the animal. It generally fits the aperture of the shell, but is sometimes smaller, in which case it is drawn inside until the animal adjusts it to the diminished circumference of the whorl. Nearly all the predaceous tribes have this protection; but it is never found among such as envelop their shell in the lobes of their mantle.

Ovate. Not oval, but egg-shaped; one extremity being thicker and more obtuse than the other.

Patelliform. Dish shaped, as the limpets.

Pectinated. Processes resembling in form and arrangement the teeth of a comb, as are the spines of some species of *Murex*.

Perforated. As if bored or indented by an awl: the holes or perforations in the ear-shells are of this description.

Plicated. Applied to any part of a shell which has plaits or folds, either upon the pillar or the external surface: the concentric ridges so common in the genus *Venus* are also of this description.

Posterior margin. This term is confined to acephalous bivalves, and is that side of the bosses which contains the ligament.

Ramose. Spines upon shells which send out others in a lateral direction, are termed ramose or branched.

Recurved. Turned backwards, in contra-distinction to incurved. The canal of some *Strombi* and *Cerithium* are remarkably recurved. The apex of all the patelli-

form shells, however, are not always incurved, the top bending downwards or being erect.

Reflected. Turned or folded backwards, as is the thickened outer lip of the common garden, and many other of the terrestrial, snails.

Reverse Shells, are such as have the aperture opening on the left side when it is placed in front of the spectator.

Sinuated, or waved. Any part whose margin has one or more undulations: this appearance is produced by a projecting lobe being followed by a notch or hollow more or less deep. The outer lip of *Struthiolaria* and several of the *Strombi* are sinuated, but the latter so much so as to form abrupt lobes and corresponding notches.

Sessile. Destitute of any support or peduncle, as in the shell of the *Anomia.* Those of *Terebratula,* on the contrary, are elevated in some degree, on a peduncle, and are termed pedunculated.

Siphon. A sucker: a fleshy process, generally long, cylindrical, and hollow; protruded by the carnivorous and testaceous animals from the base or channel of their shells. The same term is given to the slender shelly tube which connects the chambers of cephalopod shells, or the *Nautili.*

Spire. Those volutions of a spiral shell which are above the lowest or body-whorl, collectively form the spire of the shell, whatever shape it may assume. The variations in the form of this part are numerous. In some it is excessively lengthened; in others it is not even raised above the body-whorl. In *Planorbis* the spire is sunk, while in *Cypræa* it is so small as only to be seen when the shell is young, after which it is covered over by the enlargement of the body-whorl or principal volution.

Squamose. Having the appearance of scales.

Striated. Marked with lines, either elevated or raised, at parallel and nearly equal distances. Such marks are termed striæ only when they are very slender, not much exceeding the breadth of a hair, or at most of the human nail: when they are deeper and indented, they are termed grooves; or, if elevated, ridges. Sometimes the striæ are formed by a series of punctures, as in *Mitra cardinalis*, &c.; while in other instances they are elevated and granulated, as *Mitra granulosa*. In bivalve shells they are almost always concentric, or following parallel to the outer margin. All these variations have been found of great importance in the determination of species, and hence require the closest attention.

Sub. Nearly or partially, as sub-striate, sub-fusiform, &c.

Subulate. Awl-shaped, long, slender, and acutely pointed, as *Terebra, Turritella*, &c.

Sulcated. Broad grooves, sunk beneath the surrounding surface.

Suture. A term applied to the line of junction in the whorls of spiral shells, or that where two parts join or fit into each other.

Symmetrical. Where the two sides of a shell are alike.

Terebrating Testacea are such as take up their habitations in other substances, as *Pholas*, &c.

Tessellated. Divided into squares or chequers, either by a division of the colours, or by the crossing of the striæ.

Transverse. A line drawn across the breadth of a shell. Thus the coronations of the *Volutes* are transverse, so also are the bands on the *Achatinæ*, and all those upon bivalve shells which radiate from the bosses.

Trigonal or triangular. Having three equal or unequal sides, as *Donax, Hyria, Cardissa*, &c.

Trilobate. Divided into three obtuse divisions or lobes.

Tricuspidate. When these divisions end in points.

Truncated. Ending abruptly, as if cut off, as in the extremities of the typical *Soleus, Mya truncata,* &c. The same term may be applied to the termination of the spire in several land-shells, which seem as if they had been broken off.

Tubivalves. Such bivalves, like *Teredo,* as are provided also with a tube.

Turbinated. Turban or top-shaped; the whorls convex, and generally but very little raised. The garden snails are good examples, but not the *Trochi,* their form being pyramidical.

Umbilicus. A hollow opening, more or less wide, on the side of the inner lip of spiral shells: in some, as *Scalaria* and *Sollarium,* it is so deep as to extend to the apex of the shell; in others, as *Trochus,* it is small; in *Bulimus* it becomes nearly obsolete; and in *Natica* it is often entirely concealed by the spreading of the inner lip. In all these variations, however, the umbilicus is caused by the inner edges of the whorls not touching each other. Instances occur in certain land-shells which are deeply umbilicated when young, but not at all when old.

Undulated. Waved; nearly synonymous with sinuated, but more particularly applied to the colouring of shells. *Scapella undulata* and many other volutes are marked in this way.

Valves. The two ordinary or principal pieces which comprise the covering of acephalous *Testacea,* or bivalves.

Varix. Those strong elevated ridges which cross the whorls of several of the predaceous genera, as *Murex, Triton,* &c.: they mark the progressive enlargement of the shell, being the remnants of former apertures, beyond which the animal, when

grown, forms another aperture. Sometimes, as in *Murex*, these varices are irregular, and are either spined or foliated; but in the harp-shells they are smooth and at equal distances. In *Ranella* they are united, so as to form two lateral ridges; while in *Triton* they are detached and remote from each other. In *Cassis* they are also alternate; and, in the aberrant species, none whatever are perceived.

Volution. Synonymous with whorl.

Whorl. Each complete turn of the spire in a spiral shell is termed a whorl: the last, which terminates with the aperture, is the body or basal whorl; the rest are the spiral whorls.

APPENDIX.

The following note on the extraordinary genus *Herpa*, from the Guilding MSS., and referred to in the text, is too valuable to be omitted.

HERPA *Guilding.*

Animal terrestre, pulmoniferum. *Corpus* molle, subgelatinosum, mucrone obductum, elongatum, contractile, depressum, anticè præsertim attenuatum. *Os* apicale, minutissimum, obscurum. *Facies* contracta, emarginata. *Tentacula* nulla. *Scutum* nullum. *Oculi* cervicales. *Solea* magnitudine corporis, nec distincta. *Glandulæ* plurimæ ventrales mucorem ab ore transverso effuadentes, unica majore centrali, equâ viscus lobatum, molle, plicatile, parvulum, rare protruditur.

Genus valde distinctum, et inusitatæ formæ. Corpore fere toto erecto *Herpa* more serpentum prolabitur, viam mucore superillinens, et tentaculis carens cervice longo valde attenuato vestigia diriget. Genus Planariis facie quam plurimum *analogum*, ut Limacibus respirationis modo, locis, moribusque omnino *affine*.

In the 8th number of the Zool. Journ. p. 443. a short notice of this genus was given, drawn from a single specimen which must now be struck out. The capture of many of them has enabled me materially to improve the description. They are very singular animals, and in their external characters have a remarkable resemblance to the *Planariæ*, which, however, as Cuvier observes, inhabit only salt or fresh water, and therefore can have no relation of affinity with *Herpa*. Probably, the *Pl. terrestris* and *candida* of Gmelin may resemble them in their economy. I have found the *Herpæ* on the decayed fronds of

palms, on the summits of high mountains, and on the dry lands within a few yards of the sea; these always seeking cool places for concealment during the day, but never approaching the water, which upon being thrown into, they instantly quit." The largest of the three species discovered by our author, was *Herpa gigas*, black above, dirty and paler beneath. It was from six to seven inches long, and was found creeping across a damp forest path; but from the strange power it possesses of contracting its body, it escaped through a small crevice of the box it was deposited in, before it could be more accurately examined.

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*** *The page references are to the Author's remarks: to avoid a multiplicity of figures, the reader is referred to the occasional tables for the classification of genera.*

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